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SERVICE MANUAL

Number 5

Stern Drive Units
TR • TRS

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Printed in U.S.A.

90-12935 1085

STERN DRIVE UNITS - TR • TRS
SERVICE MANUAL OUTLINE

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- C - Basic Cleaning and Inspection
- D - Power Package Layup and Recommissioning
- E - Propellers
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GENERAL INFORMATION

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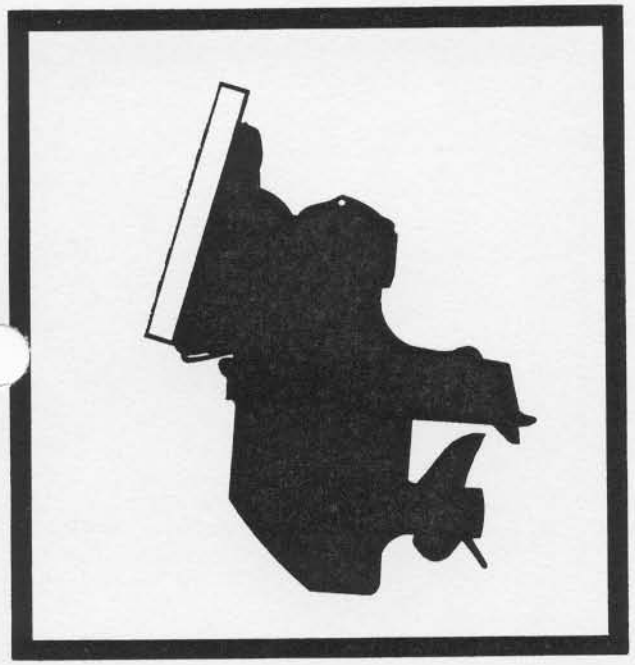
A



IMPORTANT INFORMATION

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STERN DRIVES & INBOARDS

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Notice

Throughout this publication, "Dangers", "Warnings" and "Cautions" (accompanied by the International HAZARD symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that maybe hazardous if performed incorrectly or carelessly. — OBSERVE THEM CAREFULLY! These "Safety Alerts" alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus "common sense" operation, are major accident prevention measures.

⚠DANGER

DANGER —
Immediate hazards which WILL result in severe personal injury or death.

⚠WARNING

WARNING —
Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠CAUTION

CAUTION —
Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice To Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the product described herein. It is assumed that these personnel are familiar with the servicing procedures of this product, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics' common hand tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of all possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at time of publication.

As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

Models Covered In This Manual

MCM TR/TRS TRANSOM ASSEMBLY WITH POWER STEERING
Serial Number 4922510 and above.

MCM TR/TRS TRANSOM ASSEMBLY WITHOUT POWER STEERING
Serial Number 4922285 and above.

MCM TR STERN DRIVE - Left Hand Rotation
Serial Number 5009867 and above.

MCM TR STERN DRIVE - Right Hand Rotation
Serial Number 5010092 and above.

MCM TRS STERN DRIVE - Left Hand Rotation
Serial Number 4895290 and above.

MCM TRS STERN DRIVE - Right Hand Rotation
Serial Number 4895730 and above.

How To Use This Manual

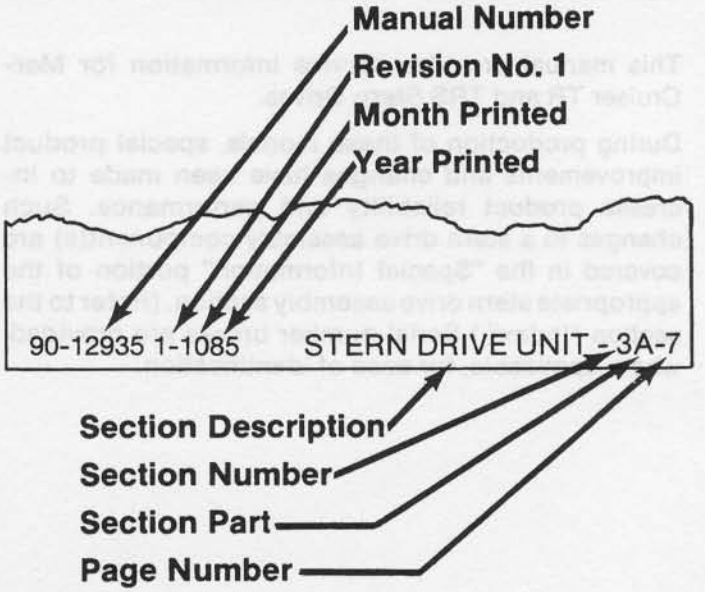
This Manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and parts are listed on page.

PAGE NUMBERING

Two number groups appear at the bottom of each page. Following is an example and description.



Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the MerCruiser models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment, to enable dealers and service mechanics to repair these products.

Before attempting repairs, it is suggested that procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

Replacement Parts

⚠WARNING

Electrical system components on MerCruiser Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing electrical systems, it is extremely important that all components are properly installed and tightened. If not, any electrical component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

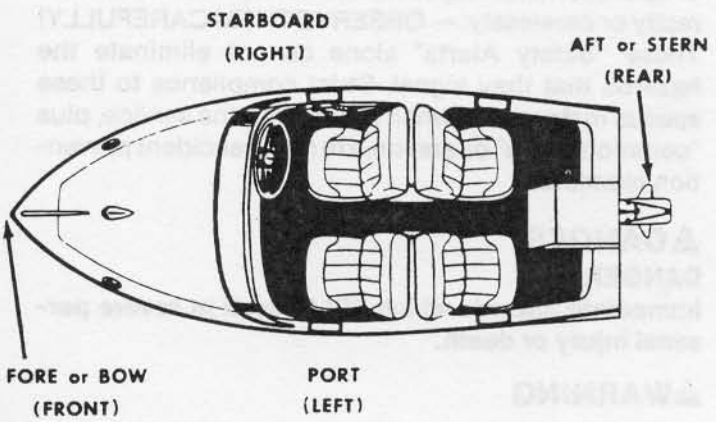
Special Product Information

This manual provides service information for MerCruiser TR and TRS Stern Drives.

During production of these models, special product improvements and changes have been made to increase product reliability and performance. Such changes to a stern drive assembly component(s) are covered in the "Special Information" portion of the appropriate stern drive assembly section. (Refer to the section "Index".) Serial number breaks are provided, where applicable, for ease of identification.

Directional References

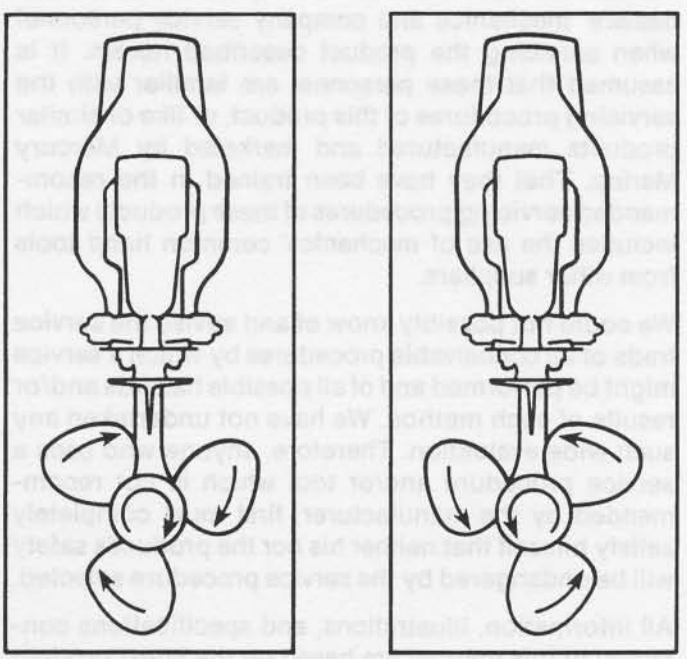
Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this service manual, all directional references are given as they appear when viewing boat from stern, looking toward bow.



Propeller Rotation

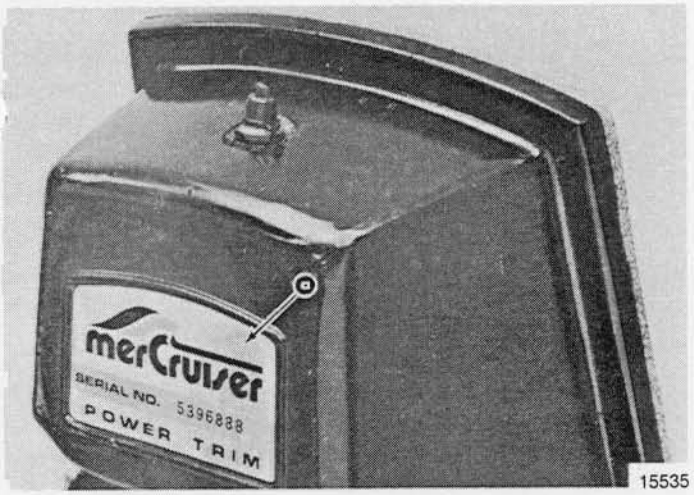
Propeller rotation for MerCruiser TR and TRS stern drives may be either the standard right rotation, or the optional left hand rotation.

Right hand rotation drive units will have an "RH" stamped on the propeller end of the propeller shaft. Left hand rotation drive units have no identifying stamp.



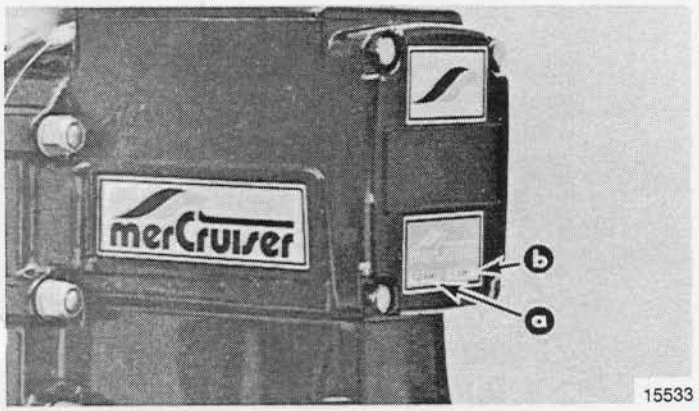
Right Hand Rotation **Left Hand Rotation**

Serial Number Locations



a - Transom Assembly Serial Number

Transom Assembly Serial Number Location



a - Stern Drive Unit Serial Number
b - Stern Drive Unit Gear Ratio

Stern Drive Unit Serial Number Location

Hi-Performance Boating

Written by marine engineers, order Part No. 90-86168, entitled "Hi-Performance Boat Operation".

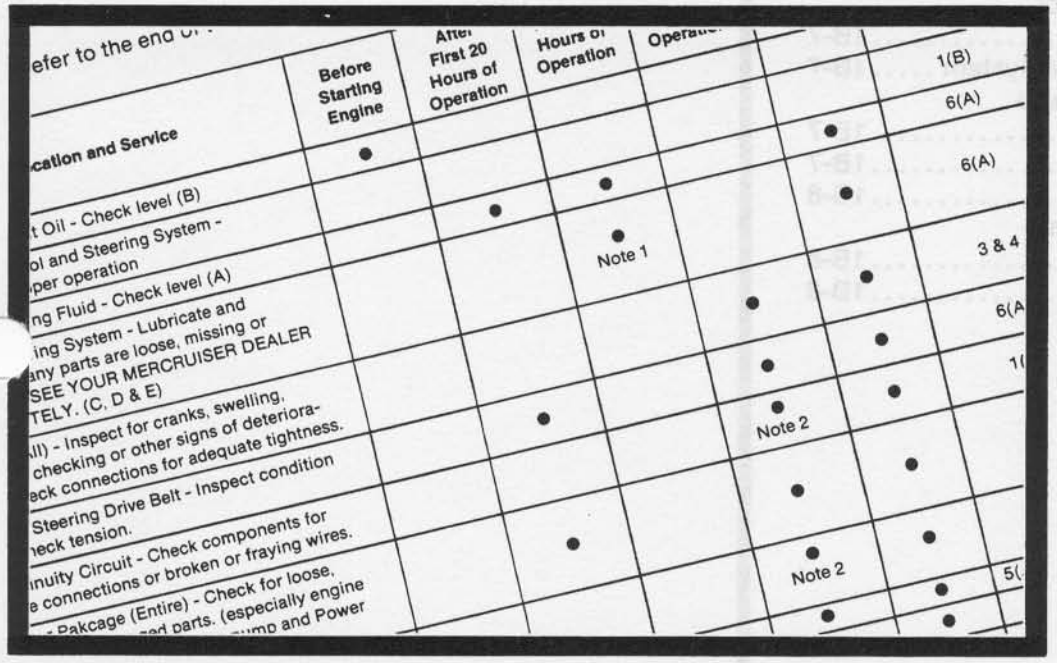
Stern Drive Unit 10-Hour Break-In Period (New or with Replacement Gears)

1. Avoid full throttle starts.
2. DO NOT operate at any one constant speed for extended periods of time.
3. DO NOT exceed 75% of full throttle during the first 5 hours. During the next 5 hours, operate at intermittent full throttle.
4. Drive unit should be shifted into forward gear a minimum of 10 times during break-in, with run-in time at moderate RPM after each shift.

GENERAL INFORMATION

1

B



efer to the end of	Before Starting Engine	After First 20 Hours of Operation	Hours of Operation	Operat		
cation and Service						1(B)
t Oil - Check level (B)	●				●	6(A)
ol and Steering System - per operation		●	●		●	6(A)
ng Fluid - Check level (A)			Note 1			3 & 4
ing System - Lubricate and any parts are loose, missing or SEE YOUR MERCRUISER DEALER TELY. (C, D & E)				●	●	6(A
II) - Inspect for cranks, swelling, checking or other signs of deteriora- eck connections for adequate tightness.		●		●	●	1(
Steering Drive Belt - Inspect condition heck tension.				Note 2	●	
inuity Circuit - Check components for e connections or broken or fraying wires.			●	●	●	
Pakcage (Entire) - Check for loose, ed parts. (especially engine mp and Power				Note 2	●	5(
					●	

MAINTENANCE

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Maintenance Chart

NOTE: Refer to the end of this chart for explanation of lettered references (A, B, etc.) and "NOTES".

Location and Service	Before Starting Engine	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year	Reference Section (Part)
Stern Drive Unit Oil - Check level (B)	●					3(A)
Remote Control and Steering System - Check for proper operation	●					1(B)
Power Steering Fluid - Check level (A)		●	●		●	6(A)
Power Steering System - Lubricate and Inspect. Repair or replace loose, missing or damaged parts. (C, D, & E)			● Note 1		●	6(A)
Hoses (All) - Inspect for cracks, swelling, weather checking or other signs of deterioration. Check connections for adequate tightness.				●	●	3 & 4
Power Steering Drive Belt - Inspect condition and check tension.		●		●	●	6(A)
Continuity Circuit - Check components for loose connections or broken or fraying wires.				● Note 2	●	1(B)
Power Package (Entire) - Check for loose, missing or damaged parts. (especially engine alternator, seawater pickup pump and Power Steering pump mounting fasteners).		●		●	●	3 & 4
Shift Cable Linkage - Lubricate and inspect. Repair or replace any loose, missing or damaged parts.				● Note 2	●	1(B)
Power Trim Pump Oil - Check level (F)		●		●	●	5(A), 5(B) or 5(C)
Stern Drive Unit Oil - Change (B)				●	●	3(A)
Propeller Shaft and Nut - Lubricate and tighten. (E, D, or I)				● Note 2	●	1(B)
Transom Gimbal Housing Assembly Swivel Shaft and Pin - Lubricate. (D)				● Note 2	●	1(B)
Transom Gimbal Housing Assembly Bellows Clamps - Check tightness.				● Note 2	●	4
Transom Gimbal Housing Assembly Bellows - Inspect condition.				●	●	4
Stern Drive Unit Universal Joint Shaft Splines and Cross Bearings - Lubricate. (D)				●	●	3(B)
Engine Alignment - Check				●	●	2
Power Package Exterior Surfaces - Clean and paint. (G)					● Note 3	1 (B)
Steering Head and Remote Control - Inspect and lubricate. (D)					●	1 (B)
Quicksilver MerCathode System (Optional) - Test output.					●	1 (B)

- Chart Continued -

Location and Service	Before Starting Engine	After First 20 Hours of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	At Least Once Each Year	Reference Section (Part)
Power Package Exterior Surfaces - Spray with rust preventative (H)	Fresh Water Areas - Every 6 Weeks Salt Water Areas - Every 2-3 Weeks					1(B)
Zinc Alloy Trim Tab, Anodic Heads, and Quicksilver Anti-Corrosion Anode Kit (Optional) - Inspect for erosion.	Every 30 Days Note 3					1(B)
Water Pickup - Check for marine growth or debris.	Every 30 Days Note 4					1 (B)
Boat Bottom - Clean and paint	As Required					1 (B)

(A) Use Automatic Transmission Fluid (ATF), Type F, Dexron or Dexron II.
(B) Use Quicksilver Super-Duty Lower Unit Lubricant.
(C) Use SAE 20 or SAE 30 engine oil.
(D) Use Quicksilver 2-4-C Multi-Lube.
(E) Use Quicksilver Special Lubricant 101.
(F) Use SAE 10W-30 or SAE 10W-40 engine oil.
(G) Use Quicksilver Primer and Spray Paint.
(H) Use Quicksilver Corrosion and Rust Preventive Type II.
(I) Use Quicksilver Perfect Seal.

NOTES: (1) In fresh water areas, every 50 hours of operation or 60 days (whichever comes first). In saltwater areas, every 25 hours of operation or 30 days (whichever comes first).
(2) In fresh water areas, every 100 hours of operation or 120 days (whichever comes first). In saltwater areas, every 50 hours of operation or 60 days (whichever comes first).
(3) Requires more frequent attention, if used in extremely salty, polluted or mineral laden waters.
(4) Requires more frequent attention, if used in areas with rapid marine growth.

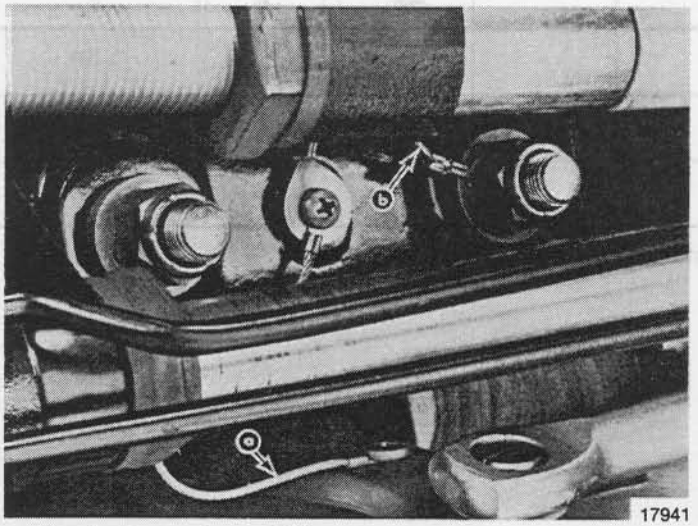
Quicksilver Maintenance Products

We recommend the use of Quicksilver Maintenance Products where specified.

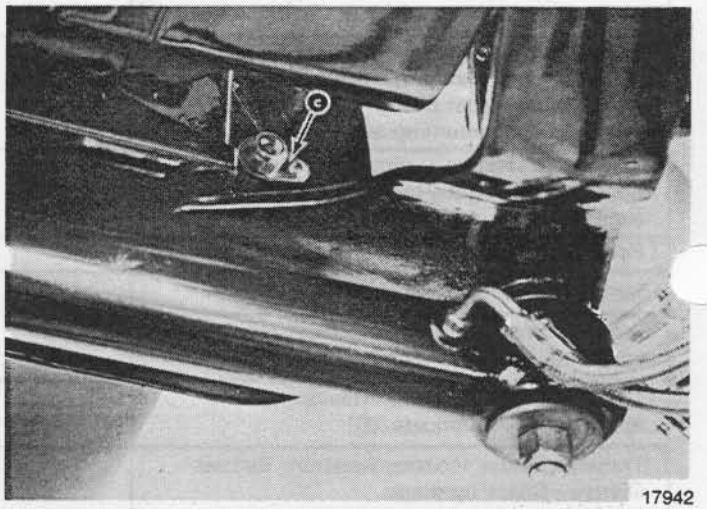
Maintaining Continuity Circuit

Transom assembly and stern drive unit may be equipped with a continuity circuit, to ensure good electrical continuity between engine, transom assembly and stern drive components. Good continuity is essential for the zinc anodes and MerCathode System (if so equipped) to function most effectively.

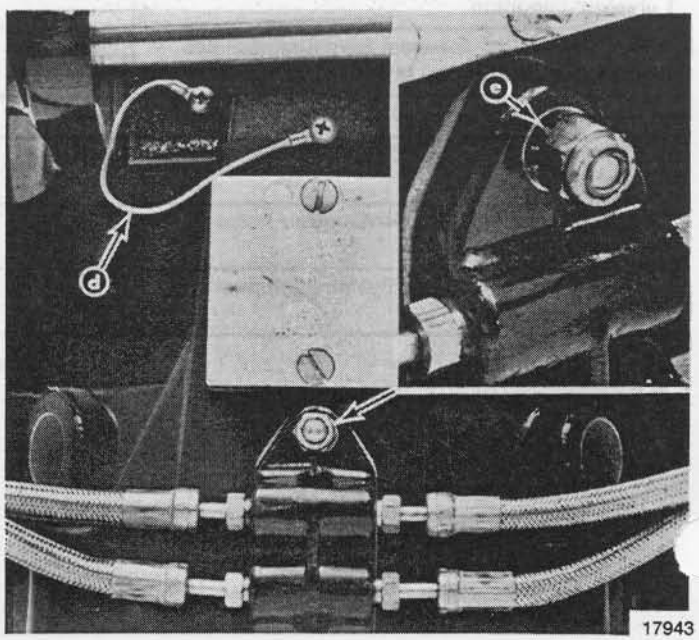
Inspect the following continuity circuit components, at intervals specified in "Maintenance Chart" for loose connections, or broken or fraying wires.



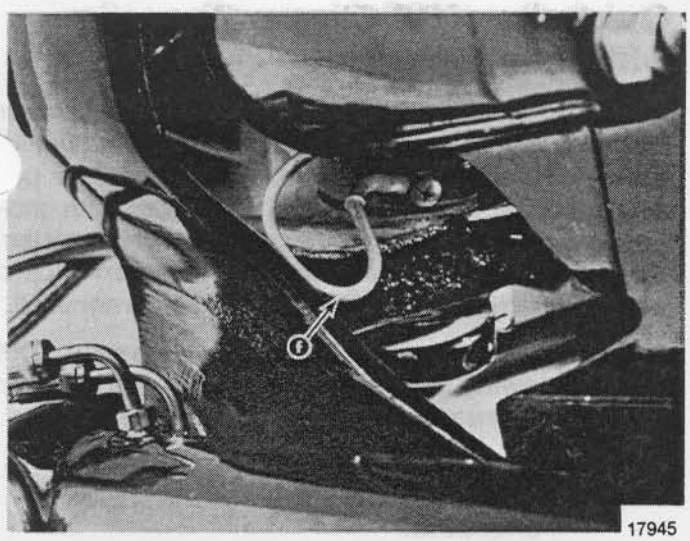
a - Steering Lever Ground Wire
b - Inner Transom Plate Ground Wire



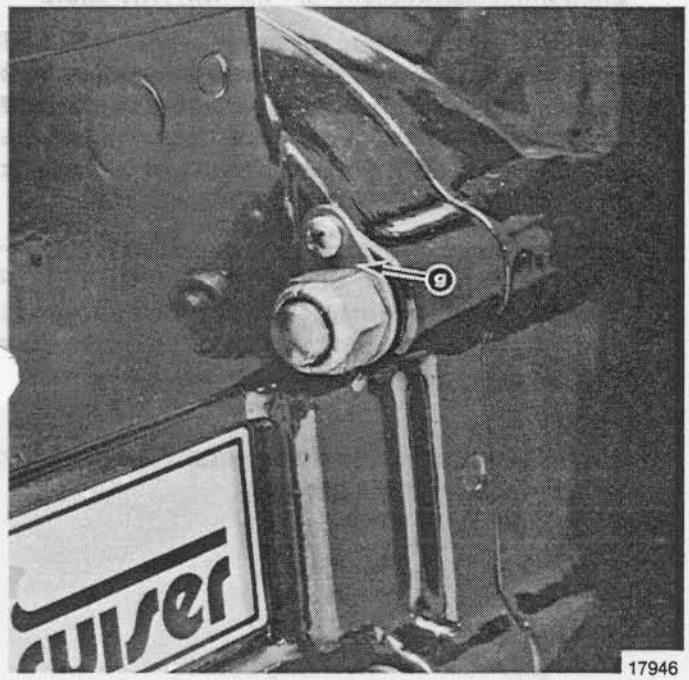
c - Gear Housing to Drive Shaft Housing Ground Plate



d - Gimbal Ring Ground Wire
e - Hydraulic Connector Ground Washer

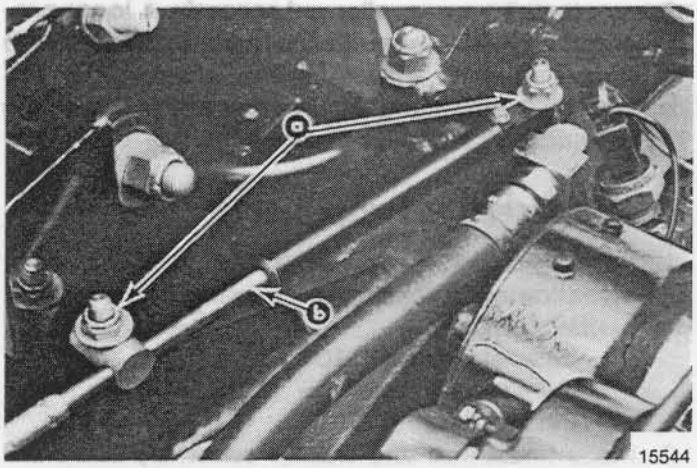


f - Bell Housing Ground Wire



g - Drive Shaft Housing to Bell Housing Ground Plate

Lubricating Shift Cable Pivot Points



a - Lubricate with SAE 20 or SAE 30 Engine Oil
b - Lubricate with 2-4-C Multi-Lube

Typical TR/TRS Shift Cable Linkage

Lubricating Propeller Shaft

⚠CAUTION

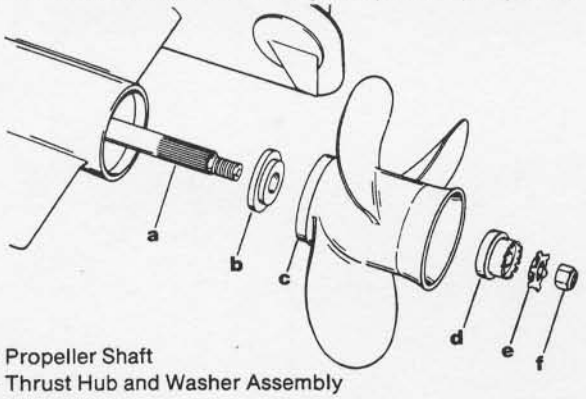
Be sure to tighten propeller nut securely. A loose propeller nut will allow propeller to move back-and-forth on propeller shaft when shifting, accelerating and decelerating, which could cause damage to thrust hub (if so equipped) and gear housing.

Quicksilver TR Propeller

1. Liberally coat the propeller shaft splines with one of the following Quicksilver lubricants (listed in order of effectiveness):
   —Special Lubricant 101
   —2-4-C Multi-Lube
   —Perfect Seal
2. Place thrust hub-and-washer assembly into front end of propeller hub with shouldered (stepped) side toward propeller hub.
3. Align splines in propeller with splines on propeller shaft and slide propeller and thrust hub-and-washer assembly all-the-way onto shaft.
4. Place spline washer assembly on propeller shaft and engage splines in washer with splines on shaft.

IMPORTANT: If tab washer is to be reused, carefully inspect tabs for cracks or other damage. Tab washer prevents propeller nut from loosening during operation and should be replaced if condition is questionable.

5. Place propeller nut into recess in tab washer and thread nut and washer onto propeller shaft. Tighten nut until a MINIMUM torque of 55 lbs. ft. (75 N.m) is attained; then, continue to tighten nut until 3 of the tabs on tab washer align with grooves on splined washer assembly.
6. Bend 3 aligned tabs on tab washer down into grooves in splined washer assembly to secure propeller nut.
7. Recheck propeller nut torque after first use and periodically thereafter. Be sure to rebend tabs on tab washer, down into grooves in splined washer assembly after checking torque on propeller nut.



496-H

a - Propeller Shaft
b - Thrust Hub and Washer Assembly
c - Propeller
d - Spline Washer Assembly
e - Tab Washer
f - Propeller Nut

Quicksilver TR Propeller Installation

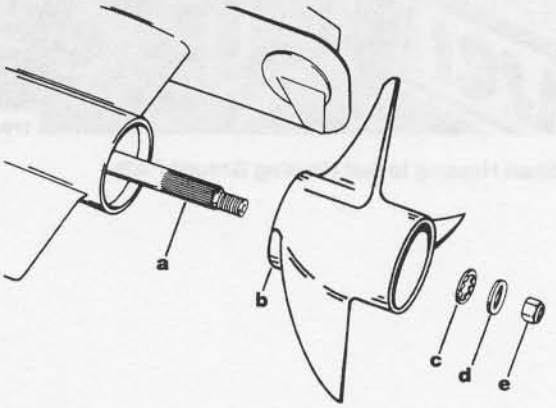
Quicksilver TRS Cleaver Propeller with Solid Drive Hub

NOTE: If changing from a Quicksilver TRS Cleaver Propeller with Square Rubber Drive Hub to a Quicksilver TRS Cleaver Propeller with Solid Drive Hub, use spline washer and flat washer (provided with propeller) along with old propeller nut to secure propeller. Front thrust hub, spline washer and tab washer (used with square rubber drive hub propeler) are not used.

1. Liberally coat the propeller shaft splines with one of the following Quicksilver lubricants (listed in order of effectiveness):
   —Special Lubricant 101
   —2-4-C Multi-Lube
   —Perfect Seal
2. Align splines in propeller with splines on propeller shaft and slide propeller all-the-way onto shaft.

IMPORTANT: If installing a new propeller, ALWAYS use new spline washer and flat washer supplied with propeller. Propeller nut also should be replaced after it has been installed and removed 4 times (to ensure good locking quality). Propeller nut is of the elastic stop nut type. DO NOT USE A REGULAR NUT.

3. Place spline washer on propeller shaft WITH CONCAVE (HOLLOWED) SIDE FACING PROPELLER and engage splines in washer with splines on shaft. If splines cannot be engaged, check to make sure that propeller is seated all-the-way on propeller shaft.
4. Install flat washer and propeller nut. Torque nut to 55 lbs. ft. (75 N.m) MINIMUM.



496-H

a - Propeller Shaft
b - Cleaver Propeller
c - Spline Washer (Shipped with Propeller)
d - Flat Washer (Shipped with Propeller)
e - Propeller Nut (Shipped with Drive Unit)

Quicksilver TRS Cleaver Propeller (with Solid Drive Hub) Installation

Quicksilver TRS Cleaver Propeller with Rubber Drive Hub

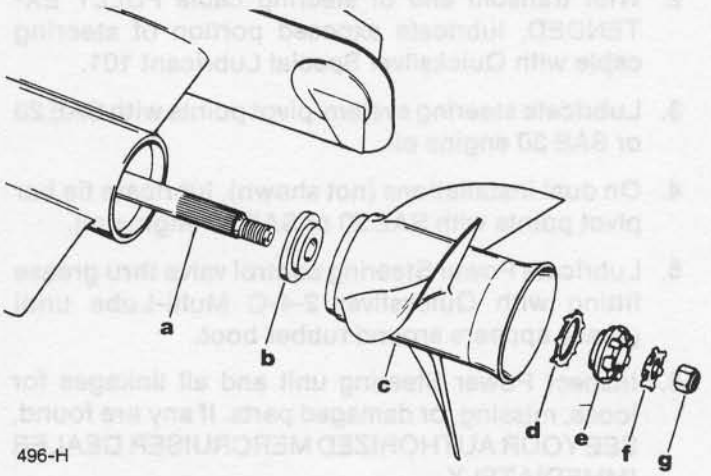
IMPORTANT: Quicksilver TRS Cleaver Propellers with Rubber Drive Hubs should be used on pleasure craft boats with stock engines only. On boats with modified (high horsepower) engines or those used for competitive purposes, Quicksilver Propellers with Solid Drive Hubs should be used.

NOTE: If changing from a Quicksilver TRS Cleaver Propeller with Solid Drive Hub to a Quicksilver TRS Cleaver Propeller with Rubber Drive Hub, a continuity washer (13-42351), a new spline washer (12-31211) and tab washer (14-31210) also are required. These parts are used in conjunction with front thrust hub (92950) (packaged with propeller) and existing propeller nut to secure propeller. Spline washer and flat washer, used to secure solid drive hub propeller, are not used.

1. Liberally coat the propeller shaft splines with one of the following Quicksilver lubricants (listed in order of effectiveness):
   - —Special Lubricant 101
   - —2-4-C Multi-Lube
   - —Perfect Seal
2. Place front thrust hub into front end of propeller hub with shouldered (stepped) side toward propeller.
3. Align splines in propeller with splines on propeller shaft and slide propeller and thrust hub assembly all-the-way onto shaft.
4. Place spline washer on propeller shaft and engage splines in washer with splines on shaft. If splines cannot be engaged, check to make sure that propeller is seated all-the-way on propeller shaft.

IMPORTANT: If tab washer is to be reused, carefully inspect tabs for cracks or other damage. Tab washer prevents propeller nut from loosening during operation and should be replaced if condition is questionable.

5. Place propeller nut into recess in tab washer and thread nut and washer assembly onto propeller shaft. Tighten nut until a MINIMUM torque of 55 lbs. ft. (75 N.m) is attained; then, continue to tighten nut until 3 of the tabs on tab washer align with grooves on spline washer.
6. Bend 3 aligned tabs on tab washer down into grooves in spline washer to secure propeller nut.



a - Apply Special Lubricant 101 on Splines of Propeller Shaft
b - Forward Thrust Hub
c - Propeller
d - Continuity Washer
e - Spline Washer
f - Tab Washer
g - Tighten Nut Until a MINIMUM Torque of 55 Lb. Ft. (75 N.m) is Attained and Continue to Tighten Until 3 of the Tabs on Tab Washer Align with Grooves on Spline Washer. Bend 3 Tabs on Tab Washer Down in Grooves in Spline Washer.

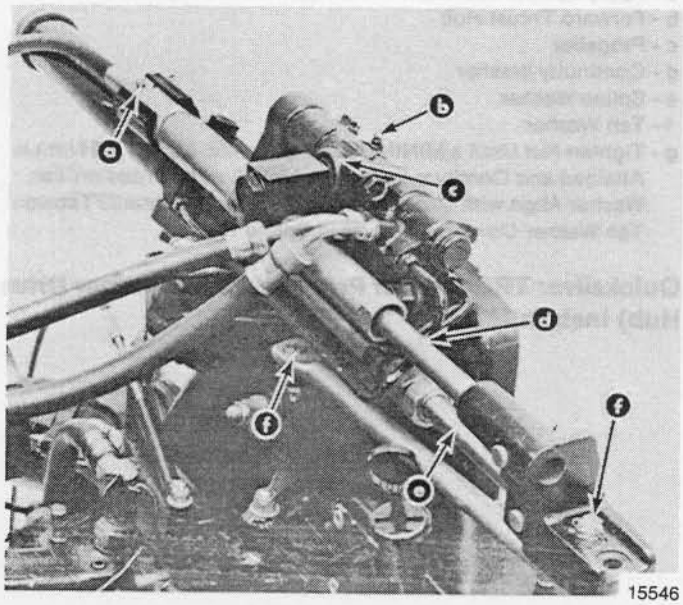
Quicksilver TRS Cleaver Propeller (with Rubber Drive Hub) Installation

Lubricating and Inspecting Steering System

⚠WARNING

Transom end of steering cable MUST BE fully retracted into cable housing when lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

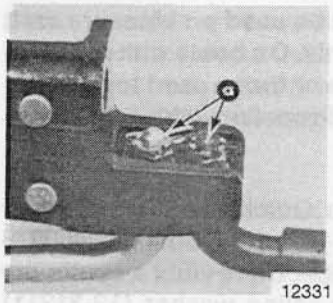
1. With transom end of steering cable FULLY RETRACTED into cable housing, lubricate steering cable thru grease fitting with Quicksilver 2-4-C Multi-Lube.
2. With transom end of steering cable FULLY EXTENDED, lubricate exposed portion of steering cable with Quicksilver Special Lubricant 101.
3. Lubricate steering system/pivot points with SAE 20 or SAE 30 engine oil.
4. On dual installations (not shown), lubricate tie bar pivot points with SAE 20 or SAE 30 engine oil.
5. Lubricate Power Steering control valve thru grease fitting with Quicksilver 2-4-C Multi-Lube until grease appears around rubber boot.
6. Inspect Power Steering unit and all linkages for loose, missing, or damaged parts. If any are found, SEE YOUR AUTHORIZED MERCRUISER DEALER IMMEDIATELY.

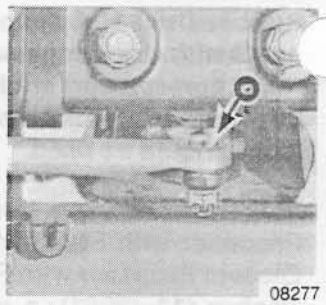


a - Steering Cable Grease Fitting
b - Power Steering Control Valve Grease Fitting
c - Rubber Boot
d - Steering Cable End
e - Power Steering Unit Extension Rod
f - Steering Link Rod Pivot Points (2 Locations)

Power Steering Unit and Steering Cable Lubrication Points

NOTE: Lubrication points for installations with External Power Steering are the same as shown in photograph preceding.

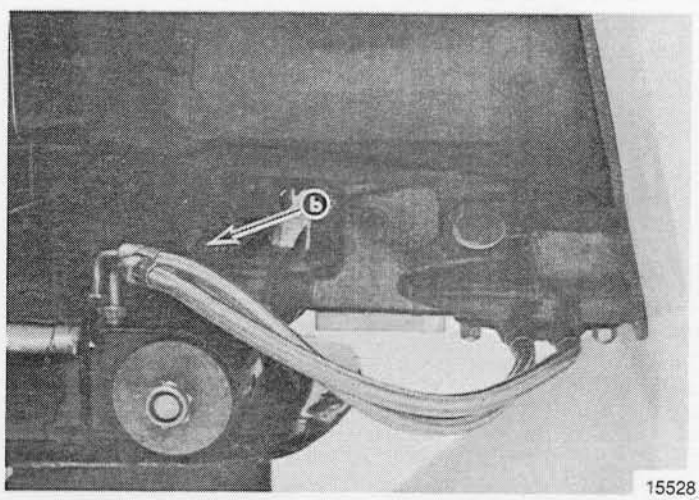




a - Pivot Point (2)

Dual Installation Tie Bar Lubrication Points

Lubricating Transom Gimbal Housing Assembly Swivel Shaft and Swivel Pin



a - Gimbal Housing Swivel Shaft
b - Gimbal Housing Swivel Pin
} Lubricate with 2-4-C Multi-Lub.

Maintaining Power Package Exterior Surfaces

Entire Power Package should be sprayed at recommended intervals with Quicksilver Corrosion and Rust Preventive Type II. Follow instructions on can for proper application.

At least once each year, entire Power Package should be cleaned and external surfaces which have become bare, should be repainted with Quicksilver Primer and Spray Paint.

Steering Head and Remote Control Maintenance

Lubricate steering head and remote control with 2-4-C Multi-Lube. Inspect Steering head and remote control for ease of operation.

Checking Quicksilver MerCathode System

If boat is equipped with a Quicksilver MerCathode System, system should be tested to ensure that it is providing adequate output to protect underwater metal parts on boat. Test should be made where boat is moored, using Quicksilver Reference Electrode and Test Meter.

Maintaining Zinc Alloy Trim Tab and Anodic Plate

Stern drive unit is equipped with a sacrificial zinc alloy trim tab and 2 anodic heads to help protect underwater metal parts from galvanic corrosion. Because of their self-sacrificing nature, trim tab and anodic heads MUST BE replaced if eroded 50% or more. To replace trim tab and/or anodic heads, proceed as follows:

Replacing Trim Tab

⚠CAUTION

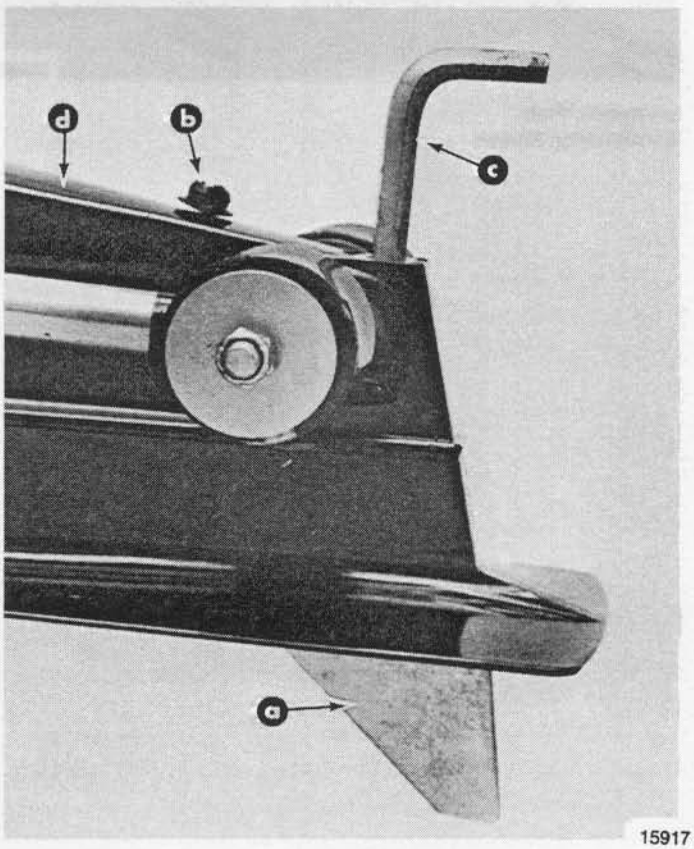
DO NOT paint new trim tab, as this will render it ineffective as a galvanic corrosion inhibitor.

1. Mark position of trim tab fin in relation to gear housing so that new trim tab can be installed in same relative position. If equipped with Power Steering, trim tab is positioned with fin straight back.
2. Remove plug from drive shaft housing to gain access to trim tab attaching screw (not shown in photo).
3. Use a 3/8 in. allen wrench and unthread tirm tab attaching screw from trim tab - DO NOT attempt to remove trim tab attaching screw.
4. Scrape trim tab mounting surface on gear housing down to bare metal.

⚠CAUTION

To be effective, new trim tab MUST make good electrical contact with gear housing.

5. Install trim tab, aligning trailing edge with index mark made in Step 1. Tighten screw securely.
6. Reinstall plug in drive shaft housing.
7. If Power Package is equipped with manual steering, adjust trim tab.



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a - Trim Tab
b - Plug
c - 3/8 In. Allen Wrench
d - Drive Shaft Housing

Replacing Anodic Plate

⚠CAUTION

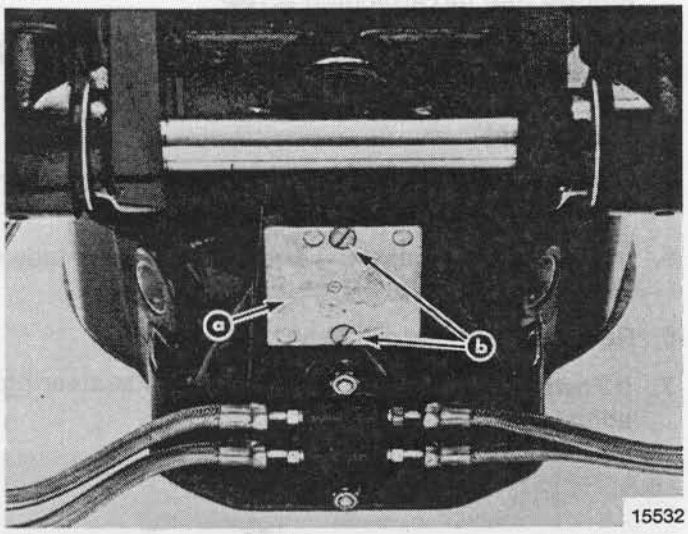
DO NOT paint new anodic plate, as this will render it ineffective as a galvanic corrosion inhibitior.

1. Remove 2 anodic plate attaching screws and remove anodic plate.
2. Scrape anodic plate mounting surface on gimbal housing down to bare metal.

⚠CAUTION

To be effective, new anodic plate MUST make good contact with gimbal housing.

3. Install new anodic plate to gimbal housing, being sure to tighten screws securely.



a - Anodic Plate
b - Attaching Screws

Checking Optional Quicksilver Anti-Corrosion Anode Kit

If boat is equipped with Quicksilver Anti-Corrosion Anode Kit, inspect anode and replace if eroded to less than 50% of its original size. Carefully follow installation instructions, that accompany new Anode Kit, to ensure proper installation.

Boat Bottom Care

To achieve maximum performance and fuel economy, boat bottom MUST BE kept clean. Accumulation of marine growth or other foreign matter can greatly reduce boat speed and increase fuel consumption. To ensure best performance and efficiency, periodically clean boat bottom in accordance with manufacturer's recommendations.

In some areas, it may be advisable to paint bottom to help prevent marine growth. Anti-fouling paints with a Tri-Butyl-Tin-Adipate base can be applied safely to the boat bottom.

⚠CAUTION

DO NOT paint anodes or MerCathode System anode and reference electrode, if so equipped, as this will render them ineffective as galvanic corrosion inhibitors.

⚠CAUTION

DO NOT use anti-fouling paints which contain copper or mercury compounds, as they will increase the rate of corrosion.

In salty, polluted or mineral-laden water areas, keep exposed metal surfaces below the waterline painted with a good quality marine paint.

GENERAL INFORMATION

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BASIC CLEANING AND INSPECTION

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STERN DRIVES & INBOARDS

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Basic Cleaning and Inspection

Cleaning

Thoroughly clean parts in solvent until all deposits have been removed. Follow solvent manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.

⚠CAUTION

When drying bearings, DO NOT spin with compressed air as bearings may become damaged.

Coat parts with oil to prevent corrosion.

Inspection

TAPERED ROLLER BEARINGS

Inpsect bearing cups and races for pitting, scoring, uneven wear, and discoloration from overheating. BOTH bearing and cup must be replaced if any of these conditions are observed.

NEEDLE and ROLLER BEARINGS

Inspect bearing contact area on shafts. Pitting, grooves, scoring, uneven wear, embedded foreign material, and/or discoloration from overheating are causes for shaft and bearing replacement.

BALL BEARINGS

Inspect ball bearings for roughness, catches, and bearing race side wear. Work inner bearing race in-and-out while holding outer race, to check for side wear.

OIL SEALS and "O" RINGS

To help ensure a good seal, it is recommended that all seals and "O" rings be replaced. If seals must be reused, inspect them for wear, cuts, hardness, roughness and proper spring tension. Inspect "O" rings for cuts, flat spots, nicks and hardness. If serviceability of seals and "O" rings is questionable, replace them.

To prevent leakage around oil seals, apply Loctite "A", upon installation, to clean, dry outer diameter of all metal case oil seals. To ease intallation, apply 2-4-C Multi-Lube to all "O" rings and oil seal lips.

SEAL SURFACES

Inspect area on shafts where seals ride. Replace shaft and seals if grooved.

GASKET and GASKET SURFACES

It is recommended that all gaskets be replaced. Inspect gasket surfaces for nicks or damage that will prevent surfaces from sealing properly.

POWER
PACKAGE
LAYUP and
RECOMMISS

POWER PACKAGE LAYUP and RECOMMISSIONING

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Power Package Layup (Out of Season Storage)

ENGINE

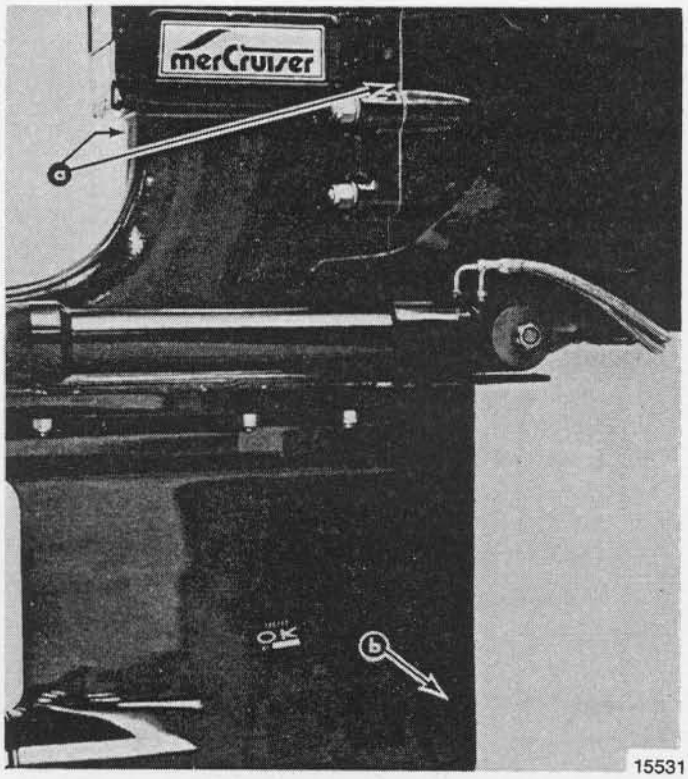
Refer to appropriate Engine Service Manual.

STERN DRIVE

1. Lubricate steering system. Refer to Section 1-B.
2. Lubricate transom gimbal housing assembly swivel shaft and pin, and propeller shaft. Refer to Section 1-B.
3. Lubricate stern drive unit U-Joint shaft splines and cross bearings. Refer to Section 3-B.
4. Inspect U-Joint bellows for cracks or other signs of deterioration. Check bellows clamps for tightness. Refer to Section 4.
5. Check engine alignment. Refer to Section 2.
6. Change stern drive unit oil. Refer to Section 3-A.
7. **⚠CAUTION**

   Water drain holes in stern drive unit MUST BE open to allow water to drain, or trapped water may freeze and cause severe damage to housings.

   Using a piece of wire, check water drain holes in stern drive unit to ensure that they are open.



a - Drive Shaft Housing Water Drain Holes
b - Gear Housing Water Drain Hole

Stern Drive Unit Water Drain Holes

8. Inspect stern drive for damage. Repair or replace damaged components.
9. Clean stern drive exterior surfaces and repaint any bare metal surfaces with Quicksilver Primer and Spray Paint. Refer to Section 1-B.
10. After paint has dried spray entire stern drive with Quicksilver Corrosion and Rust Preventive Type II. Refer to Section 1-B.
11. **⚠CAUTION**

    Store stern drive unit in the full trim "In"/"Down" position. U-Joint bellows may develop a "set" if unit is stored in raised position and may fail when unit is returned to service.

    If not already done, place stern drive unit in the full trim "In"/"Down" position.
12. Store battery, using the following procedure:
    a. Remove battery as soon as possible, and remove all grease sulfate and dirt from top surface.
    b. Fill battery with distilled water to level specified by manufacturer.
    c. Cover terminal bolts well with petroleum base grease.
    d. Store battery in a COOL, DRY place in a dry carton or box.

⚠CAUTION

A discharged battery can be damaged by freezing.

e. Remove battery from storage every 45 days. Check water level and place on charge, following battery manufacturer's instructions. DO NOT fast charge.

NOTE: Larger batteries generally will accept a higher charging rate.

f. When replacing battery in service, remove excess grease from terminals (leaving small amount on), recharge as necessary and reinstall in your equipment.

Power Package Recommissioning

ENGINE

Refer to appropriate Engine Service Manual.

STERN DRIVE

1. Perform ALL maintenance specified for completion "At Least Once Each Year" in "Maintenance Chart" (Refer to Section 1-B), except items which were performed at the time of stern drive layup.
2. Install fully-charged battery. Clean battery cable clamps and terminals and reconnect cables. Be sure to tighten clamps securely. Apply a thin coat of petroleum base grease to clamps and terminals to help retard corrosion.
3. After recommissioning and starting engine, check steering system and shift control for proper operation.

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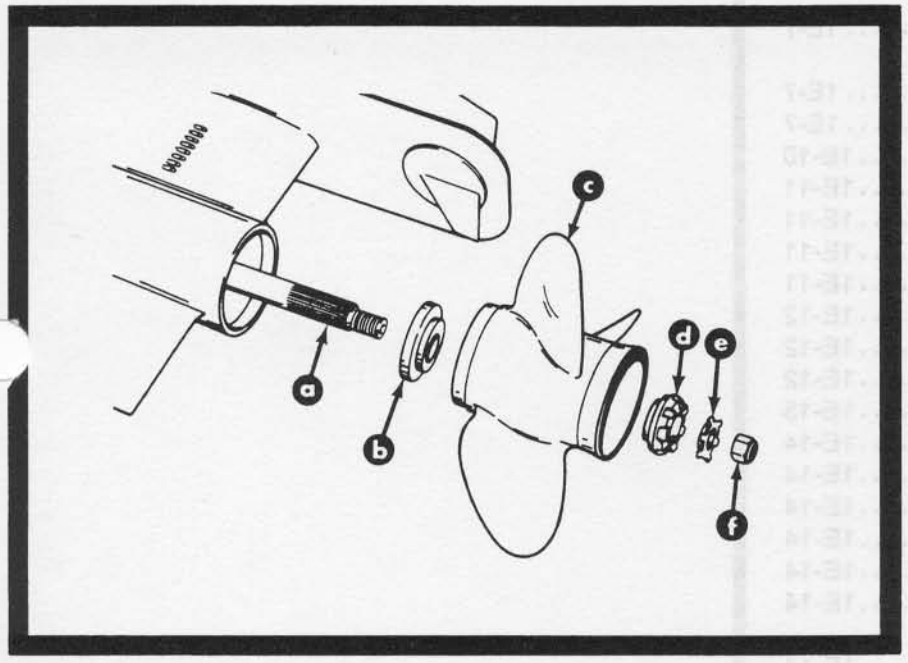

PROPELLERS

mercruiser
STERN DRIVES & INBOARDS

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Function and Engineering

What Do They Do?

A marine propeller is the primary connection between your motor and the water. Powered by the engine, it moves a boat forward or backward. Without the propeller, nothing happens.

The propeller has blades that are designed (when rotated) to move the boat forward by creating a negative or pulling pressure on one side and a positive or pushing pressure on the other side of the blades. These pressures cause water to be drawn into the propeller from in front and accelerated out the back (Figure 1). But just any propeller won't do the best job.

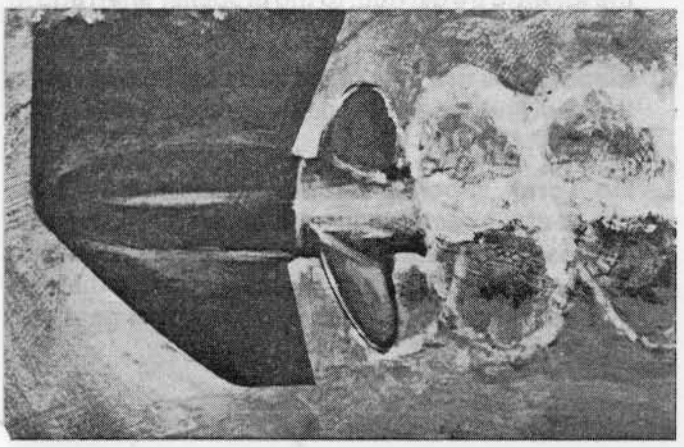


Figure 1

Choosing the correct propeller isn't that difficult; however, it must be selected for the particular job that the boat is to perform. Fishing. Skiing. Cruising. Racing. Or, if the customer uses his boat for several activities and the load varies from very light to very heavy, two different propellers might be recommended.

The waters in which the boat is operated may well determine the best material to use in the propeller. Will boating be in fresh, salt or brackish water, deep or shallow, rocky waters?

How Do They Work?

(Figure 2) Household fan with arrows showing air movement: An ordinary electric fan pulls air in from behind it and blows it out toward you. The marine propeller acts in much the same way, except that it acts on water rather than on air.

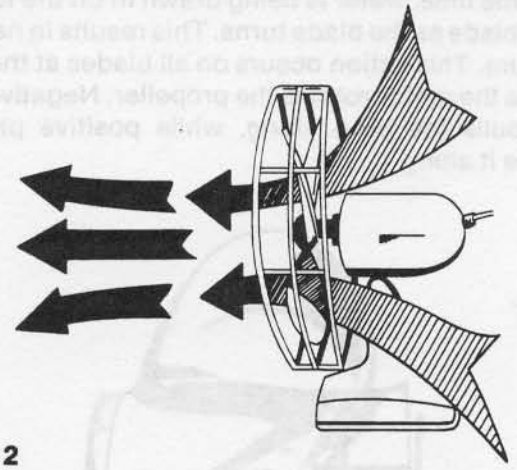


Figure 2

(Figure 3) Propeller with arrows showing water movement to it, through it, from it. The marine propeller draws or pulls water in from its front end through an imaginary cylinder a little larger than the propeller diameter. The front end is the end that faces the boat. As the propeller spins, water accelerates through it, creating a slightly smaller jet stream of higher-pressure water behind the propeller. This exiting water jet is smaller in diameter than the actual diameter of the propeller. This water jet action of pulling water in and pushing it out results in what is called "thrust". It is the pulling and pushing force that moves a boat forward.

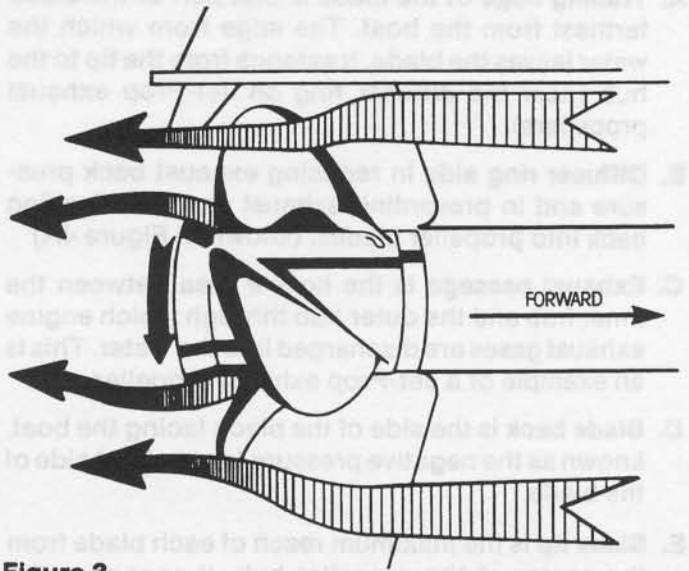


Figure 3

What Makes The Rotation Propeller Move Through The Water?

Look at the blade facing directly at you in this side view (Figure 4A). As it rotates downward, water is pushed down and back naturaly, just as it is done by your hand when swimming. This results in positive pressure. At the same time, water is being drawn in on the top side of the blade as the blade turns. This results in negative pressure. This action occurs on all blades at the same time as the motor rotates the propeller. Negative pressure pulls the prop along, while positive pressure pushes it along.

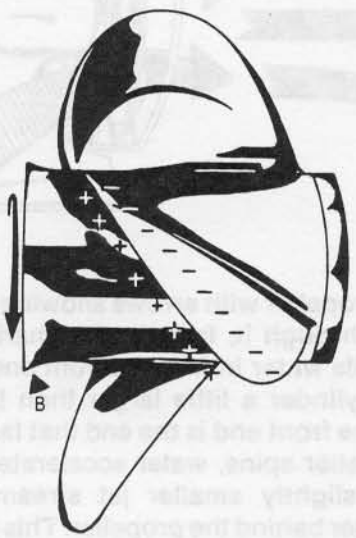


Figure 4A

What Are The Basic Propeller Parts?

A. **Trailing edge** of the blade is that part of the blade farthest from the boat. The edge from which the water leaves the blade. It extends from the tip to the hub (near the diffuser ring on Jet-Prop exhaust propellers).

B. **Diffuser ring** aids in reducing exhaust back pressure and in preventing exhaust gas from feeding back into propeller blades. (shown in Figure 4A)

C. **Exhaust passage** is the hollow area between the inner hub and the outer hub through which engine exhaust gases are discharged into the water. This is an example of a Jet-Prop exhaust propeller.

D. **Blade back** is the side of the blade facing the boat, known as the negative pressure (or suction) side of the blade.

E. **Blade tip** is the maximum reach of each blade from the center of the propeller hub. It separates the leading edge from the trailing edge.

F. **The "cup"** is a small curve or lip on the trailing edge of the blade, permitting the prop to hold water better, and adding normally about 1/2" (12.7mm) to 1" (25.4mm) of pitch.

G. **Ribs** are the connections between the inner and the outer hub. There are usually 3 ribs, occasionally 2 or 4. The ribs are usually either parallel to the prop shaft ("straight"), or parallel to the blades ("helical").

H. **Leading edge** of the blade is that part of the blade nearest the boat, that which first cuts through the water. It extends from the hub to the tip.

I. **Outer hub** (for Jet-Prop exhaust propellers) is the hub area in direct contact with the water and to which the blades are attached. Its inner surface is in contact with the exhaust gases.

J. **Inner hub** contains the rubber hub (described below). The forward end of this hub is the metal surface which transmits the prop thrust, through the forward thrust hub, to the propeller shaft and in turn eventually to the boat.

K. **Blade face** is that side of the blade facing away from the boat, known as the positive pressure side of the blade.

L. **Flo Torq® shock-absorbing rubber hub** is composed of rubber molded to an inner splined hub. Its purpose is to protect the propeller drive system and to flex when shifting the engine, to relieve the normal shift shock that occurs between the gear and clutch mechanism.

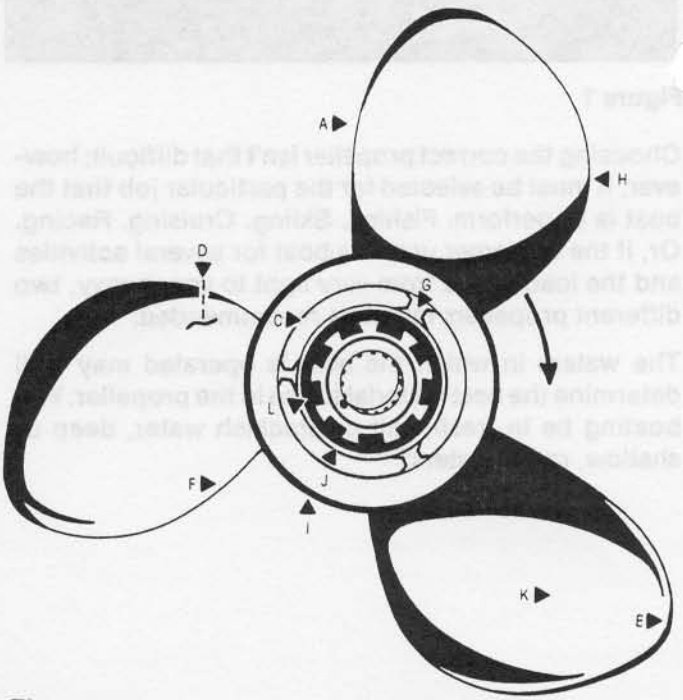


Figure 4B

Non-Jet Exhaust Propellers

Propellers may have the Flo-Torq shock absorbing rubber hub, without through-hub exhaust (Figure 5). These propeller blades attach directly to the hub. A blade design is required that will perform satisfactorily without an exhaust-gas enclosing outer hub.

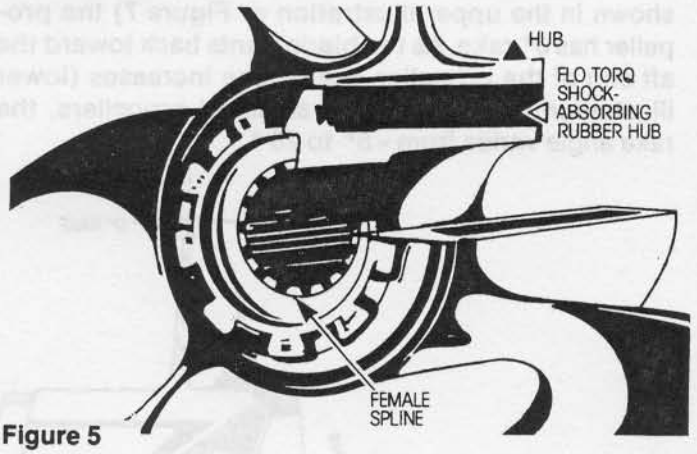


Figure 5

(Figure 5A) Propellers with solid hubs have no Flo Torq shock-absorbing rubber hub. Exhaust gases are discharged in a manner so as not to disturb the propeller action. Solid-hub propellers are generally used on racing motors which usually do not have a gear shift.

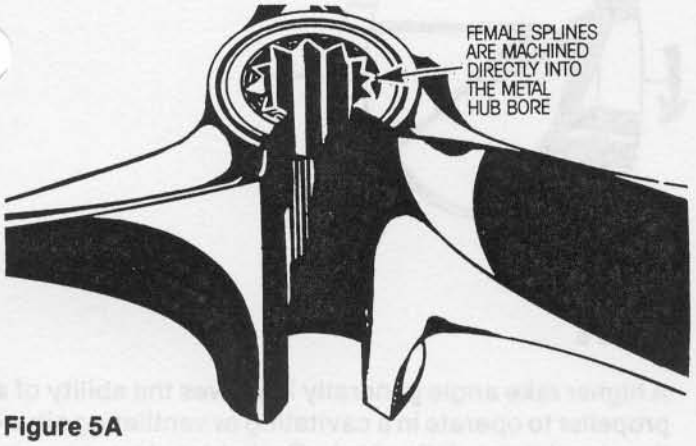


Figure 5A

What Is Pitch?

Pitch is the distance that a propeller would move in one revolution (if it were traveling through a soft solid — like a screw in wood) (Figure 6).

When a propeller is identified as 13x21, it has a 13" (33cm) diameter with 21" (53cm) of pitch. Theoretically, the propeller would move forward 21" in one revolution.

Propeller Pitch

Actual propeller pitch can vary from the advertised pitch stamped on the propeller. One cause is minor distortion that can occur during the casing and cooling process. Another cause is adjustments or modifications made by propeller repair stations. Finally, undetected damage may have altered the pitch.

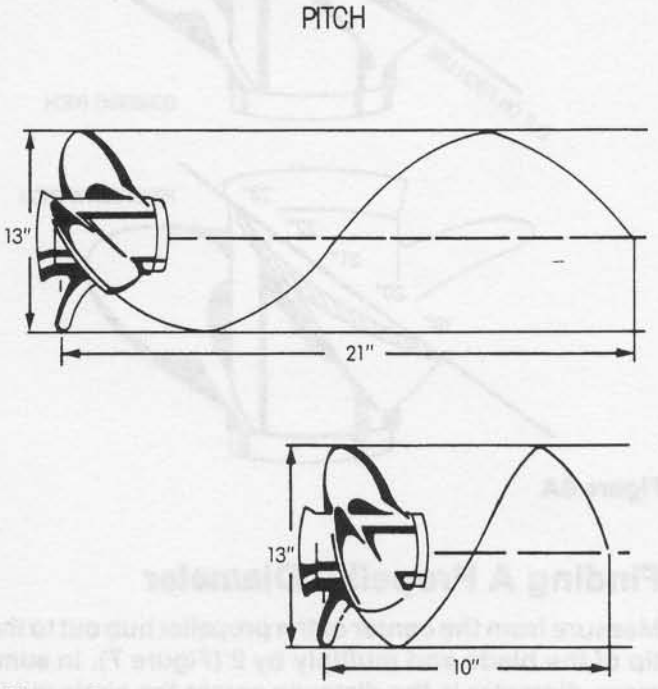


Figure 6

What is Progressive Pitch?

Progressive pitch (Figure 6A), also called blade "camber", is a blade design innovation that improves performance when forward and rotational speed is high and/or the propeller breaks the water surface.

Progressive pitch starts low at the leading edge and progressively increases to the trialing edge. The pitch number assigned (example, 21") is the average pitch over the entire blade. It is commonly used on mid-to high-horsepower Quicksilver® propellers.

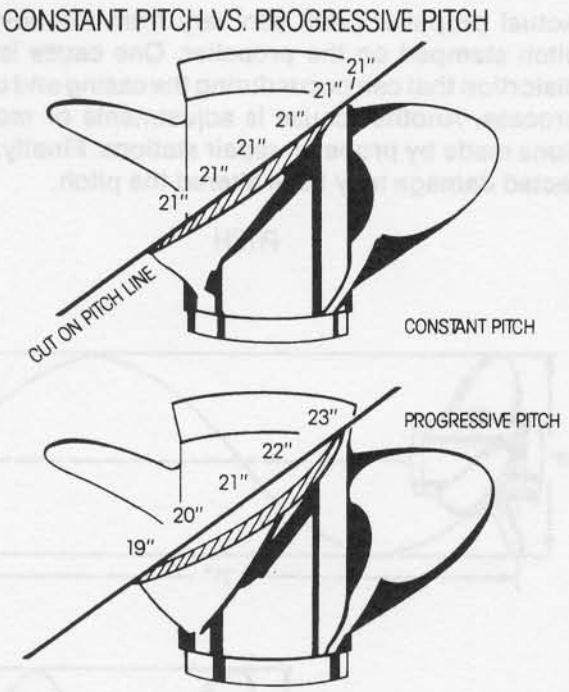


Figure 6A

Finding A Propeller Diameter

Measure from the center of the propeller hub out to the tip of the blade and multiply by 2 (Figure 7). In summary, diameter is the distance across the circle made by the blade tips as the propeller rotates.

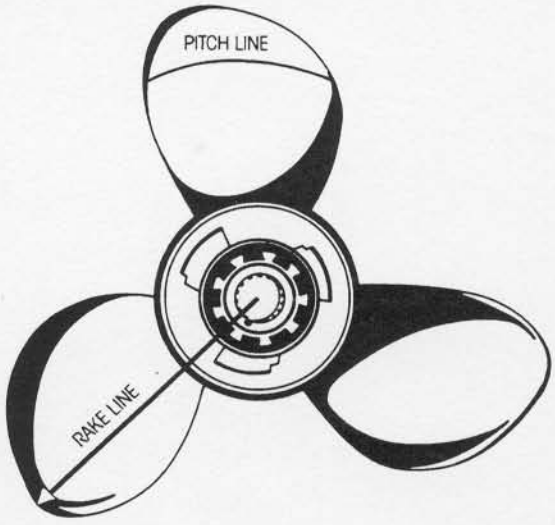


Figure 7

What Is Blade Rake?

When a propeller blade is examined on a cut extending directly through the center of the hub, as in Figure 7, the cross section of that cut blade (as viewed in Figure 8) would represent blade rake.

If the blade is perpendicular to the propeller hub (as shown in the upper illustration or Figure 7) the propeller has 0° rake. As the blade slants back toward the aft end of the propeller, blade rake increases (lower illustration, Figure 8). With standard propellers, the rake angle varies from - 5° to 20 °.

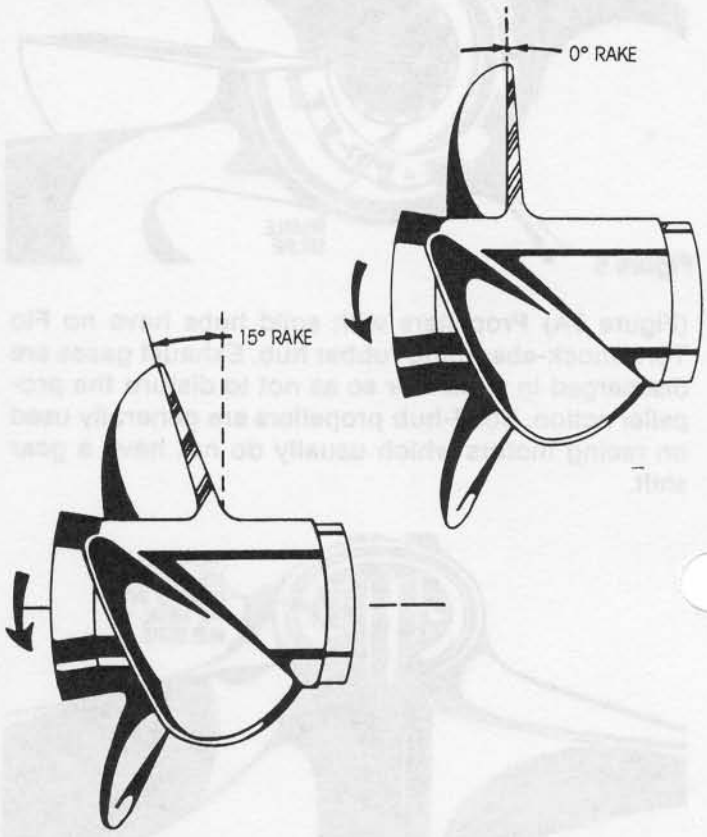


Figure 8

A higher rake angle generally improves the ability of a propeller to operate in a cavitating or ventilating situation (explained, following). On lighter, faster boats, with a higher engine or drive transom height, higher rake often will increase performance by holding the bow of the boat higher.

Why Does Blade Thickness Vary?

Like a tree growing from a tree trunk, so a blade is thickest where it meets the hub. As the blade moves out from from the tip, it becomes thinner (Figure 9). The basic reason: like any cantilever beam, the load that any blade or beam section must support decreases to zero at the tip or free end.

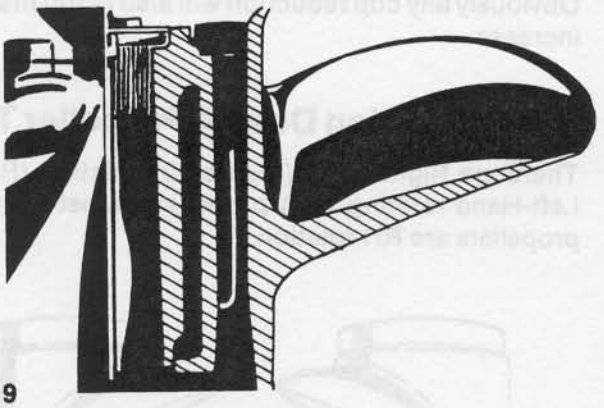


Figure 9

Since there is only so much power available, blades should be as thin as practical (considering the strength of their material) because it takes more power to push a thick blade through the water than a thin blade.

But what about the thickness variation from the leading to trailing edge? When viewing a common blade cutaway at a given radius from the center (Figure 10), an approximate flat surface will be observed on the pressure (positive) side and a circular arc surface on the suction (negative) side (with the thickest point in the center). Edges usually are .060" to 080" (1.5mm to 2.0mm) thick for aluminum props, thinner for stainless steel.

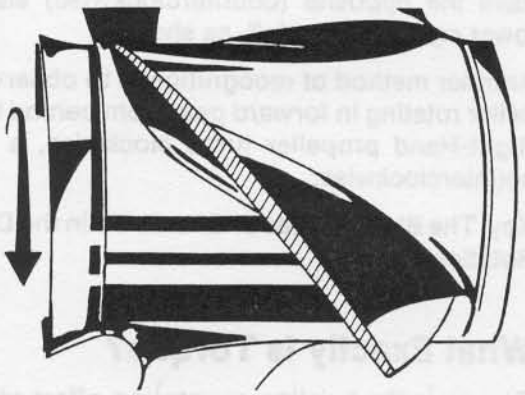


Figure 10

For propellers intended to run partially surfaced as in racing applications the "cleaver" blade shape is popular. Its blade section is usually a wedge. Blades with a thick trailing edge such as this should only be run surfaced. When they are run deep, where surface air can't ventilate the low-pressure cavitation pockets formed behind the thick trailing edge, they are less efficient.

What Is Cupping?

When the trailing edge of the blade is formed or cast with an edge curl outward (away from boat), it is said to have a cup (Figure 11). Generally, cupped blades improve the planing performance of a boat. The cup helps the blades "hold" (not break loose) when operating in a cavitating or ventilating situation. This, then, permits the stern drive to be trimmed out futher or be mounted higher on or in the transom, particularly on faster boats. Either adjustment usually adds to top speed.

Figure 11

The cup may have the effect of adding pitch to the blade, as well as rake. Cupping usually will reduce full-throttle engine speed about 150 to 300 RPM below the same pitch prop with no cup. A propeller repair shop can increase or decrease cup to alter engine RPM below the same pitch prop with no cup. A propeller repair shop can increase or decrease cup to alter engine RPM to meet specific operating requirements. Cups are standard on most Quicksilver propellers.

For a cup to be most effective, it should be completely concave (hollowed) and finished with a sharp trailing edge. Any convex rounding of the trailing edge of the cup detracts from its effectiveness.

Cupping is usally of no value on props used in heavy-duty or work applications where the prop remains fully submerged.

Importance of Cup Location

Using a round bladed propeller as an example, if the cupped area intersects pitch lines, as in Figure 12, it will in effect increase blade pitch.

Cupping is this area will reduce RPM by adding pitch. It will also protect somewhat against propeller "blow-out" (See "Index" for "Blowout" explanation).

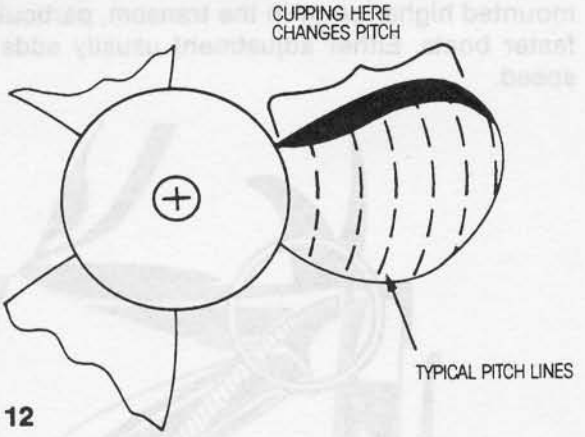


Figure 12

If the cup is placed so that it intersects rake lines, Figure 12A, it then has the effect of increasing rake. The benefits of blade rake are previously explained.

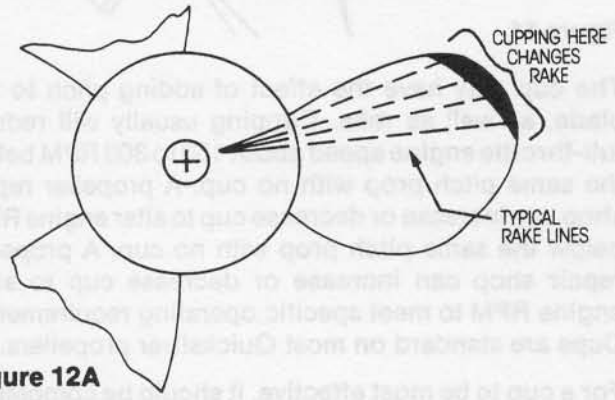


Figure 12A

There is clearly some overlap where cup affects both pitch and rake.

In some cases adding a normal cup has reduced engine RPM by an unusually high number, as much as 1000 RPM. This can happen if the uncupped propeller was running partially "blown out", a situation not uncommon and often undetected until a cupped propeller is tried. A partially blown out propeller has a mushy, somewhat unresponsive feel, and may produce excessive prop spray. An accurate SLIP calculation (explained following) can be beneficial here. Slip will generally jump from its normal 10% - 15% to over 20% for a partially "blown out" prop (on an average - to light-weight boat).

Adjusting the cup on a cleaver-style propeller is more difficult. Since the trailing edge is very thick and runs straight out on a rake line, any adjustment will have far less effect on altering rake. Pitch can be reduced substantially by filling or grinding away some of the cup. At the same time rake will be altered slightly. For less rake, decrease the cup in the area close to the tip. For more rake, reduce the cup in the area close to the hub. Obviously any cup reduction will also result in an RPM increase.

What Direction Does A Propeller Turn?

There are Right-Hand (Figure 13) rotating (RH) and Left-Hand rotating (LH) propellers. Most stern drive propellers are RH rotation.

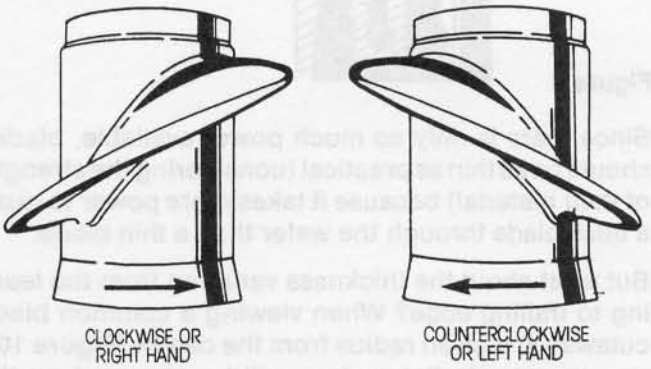


Figure 13

To recognize a Right-Hand propeller, observe the prop from a position shown in the "Clockwise" illustration and note that the Right-Hand prop blade slants from lower left to upper right. A Left-Hand propeller will have the opposite (counterclockwise) slant - from lower right to upper left, as shown.

Another method of recognition is to observe the propeller rotating in forward gear from behind the boat. A Right-Hand propeller turns clockwise, a Left-Hand counterclockwise.

Key: The Blade Slopes or Climbs Up in the Direction of Rotation.

What Exactly Is Torque?

Torque is the twisting or rotating effort of any shaft. The transfer of torque or twisting force from the drive shaft to the propeller shaft is made through gears. The torque developed at the engine thus is delivered through shafts and gears to the propeller; however, there usually is a 5% to 10% loss of torque due to the friction between moving parts. Torque is related to horsepower and shaft speed (RPM) by the following relationship

$$\text{Torque} = \frac{\text{Horsepower} \times 5250}{\text{RPM}}$$

What Does Motor Gearing Have To Do With Torque?

When there is no gear reduction in the stern drive, a 4000 engine RPM turns the propeller at 4000 RPM. This normally is used for high-speed racing applications. If a gear reduction is used, however, the 4000 engine RPM is reduced to 2000 RPM at the propeller, a two-to-one (2:1) gear reduction exists. Therefore, by cutting propeller shaft speed in half the torque has been doubled.

As the higher torque is transmitted to the propeller shaft with more gear reduction, a larger diameter propeller is required. A slower-turning, larger-diameter propeller is more efficient than a faster-turning, smaller-diameter propeller. This usually means better acceleration as well as better top speed, up to the point where the higher drag of the larger, higher reduction gearcase overtakes the propeller-efficiency benefit.

But what about the propeller pitch? The pitch acts like another set of gears with a given boat and load. Correct pitch is evident when, at wide-open-throttle, the engine runs within the manufacturer's specified RPM range.

One other fact: The faster the boat moves (given a specific engine and gear ratio), the smaller the ideal propeller diameter will be. As observed in a propeller chart, the propeller diameter goes down as the pitch goes up. (Fully submerged propellers only.)

How Does Propeller Torque Produce Boat Roll?

When observing from behind a boat, the propeller turns clockwise when underway (with normal right-hand propeller). As water resists the clockwise rotating propeller, it causes the boat to roll slightly in the opposite direction (counterclockwise) or down on the left (port) side and up on the right (starboard) side. To offset this slight imbalance, the driver's seat is placed on the right (starboard) side. Boats differ significantly in the degree of their reaction to prop torque.

What Is Propeller Slip?

In order to understand "slip" it is helpful to probe deeper into how a propeller works by first comparing it to an airplane wing. The wing of an airplane and its ability to carry the weight of the airplane by providing LIFT is very similar to the spiraling travel of a propeller blade which provides THRUST. It is important to appreciate the concept of "Angle of Attack" and how it relates to "SLIP"

If a wing with a symmetrical airfoil (Figures 14 and 15) is moved through the air so that air moves symmetrically above and below the wing, there is equal pressure above and below resulting in no "lift". The wing is said to be operating at zero degree (0°) angle of attack.

With an angle of attack (Figure 14A and 15A), there is a pressure change above and below the wing which creates lift [lower (negative) pressure on the top and higher (positive) pressure from below].

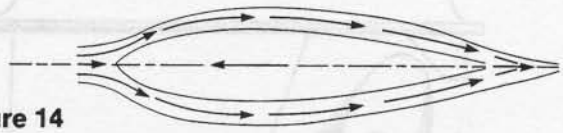


Figure 14

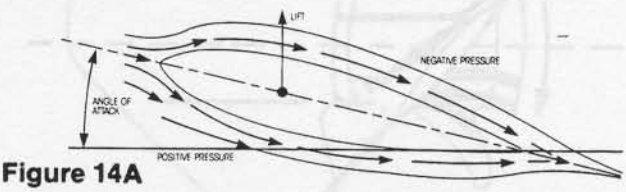
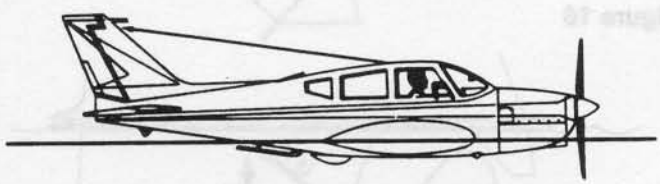


Figure 14A



NO ANGLE OF ATTACK – NO LIFT – WILL NOT FLY

Figure 15

WITH ANGLE OF ATTACK – LIFT – WILL FLY

Figure 15A

Although it is clear that the airplane wing and the propeller blade move through air and water respectively, marine engineers prefer to talk about the situation in terms of the water moving into the blade. Allowed that freedom, consider the following diagrams showing the same angle of attack phenomena, only in this case, for the propeller blade.

Water entering at no (zero) angle of attack. This creates no positive or negative pressures on the blade, therefore there can be no lift or thrust (Figure 16).

Water entering with some angle of attack, which causes a pulling (negative pressure) on one side and a pushing (positive pressure) on the other side (Figure 16A). The combined pressures cause lift at approximately right angles to the blade surface. Lift can be divided into a Thrust component in the direction of travel and a Torque component in the opposite direction of propeller rotation.

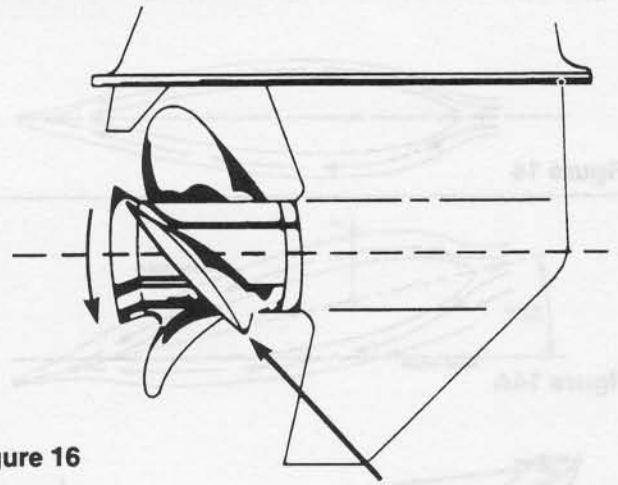


Figure 16

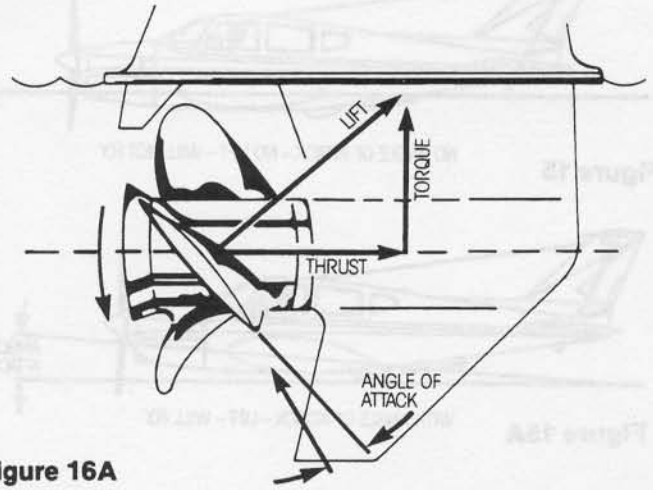


Figure 16A

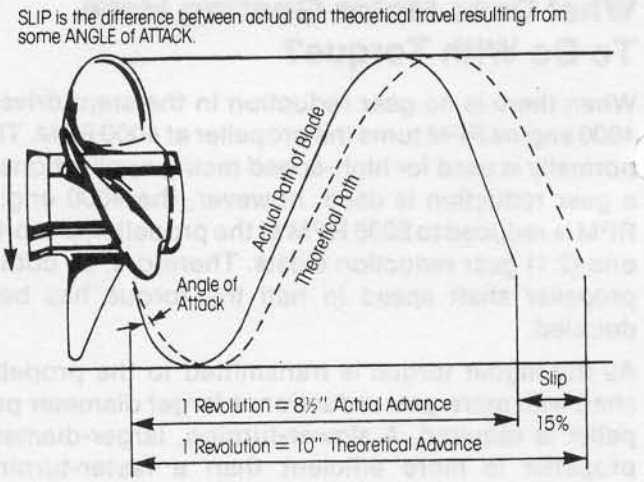


Figure 17

In the example Figure 17, a 10" pitch propeller actually advances only 8-1/2". This is 85% of 10" leaving a slip of 15%. If the blade had no angle of attack there would be no slip but, of course, there would be no positive and negative pressure created on the blades and therefore there would be NO THRUST. To create thrust there MUST be some angle of attack or slip. The objective of propeller design is to achieve the right amount of slip or angle of attack which is around 4°, give or take a degree. This is accomplished by matching the right amount of blade diameter and area to the existing engine horsepower and propshaft RPM. The chart in Figure 18 illustrates this point.

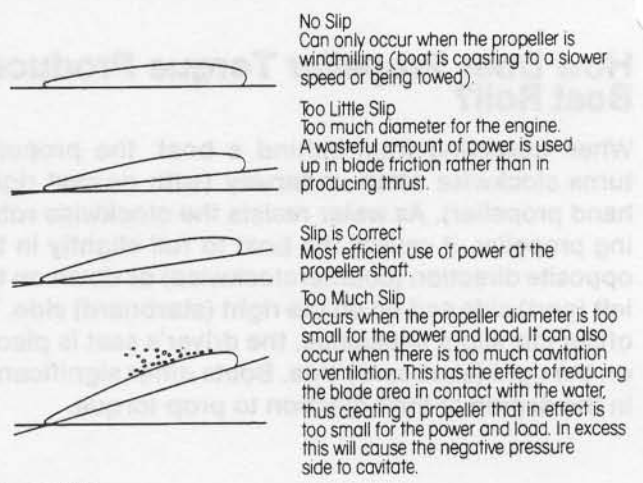


Figure 18

The following shows another way of tying in angle of attack and slip through considering rotational and forward velocities. Propeller engineers like to study propellers at the 7/10 radius (70% of the distance from the propeller center of rotation to the blade tip) which generally is the section of the propeller blade that is most typical of the whole blade. The 7/10 radius rotational velocity (speed in MPH at which the 7/10 radius is rotating) can be calculated by the following equation:

$$\text{7/10 radius Rotational Velcoity (MPH)} = \frac{\text{Propeller RPM x 7/10 Radius (in.)}}{168}$$

and can be shown by a vector (arrow) as illustrated in Figure 19. For those interested in Blade Tip Speed the following equation applies:

$$\text{The Rotational Propeller Tip Speed (MPH)} = \frac{\text{RPM Prop x DIA in.}}{336}$$

The forward velocity can be shown by an arrow in the direction of travel (Figure 19A). The length of the arrows again reflects the speed in MPH for both the measured forward velocity and the theoretical (no slip) forward velocity (see equation).

Figure 19

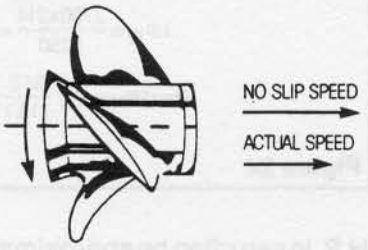


Figure 19A

When the rotational speed and forward speeds are combined in a simple vector (arrow) diagram some interesting things appear (Figure 20).

Consider the following actual example:

A 16' boat powered by, in this case, a 115 HP engine with 2:1 gear reduction, turning 5400 RPM uses a 13" diameter by 19" pitch, cupped propeller to push the boat 43.5 MPH. What is the slip and angle attack at the 7/10 radius?

Propeller Rotational Speed Equation:

$$\text{7/10 Radius Rotational Speed (MPH)} = \frac{\text{RPM Prop x Blade Radius x .7}}{168}$$

The equation applied to the example boat:

$$\text{Rotational Speed(MPH)} = \frac{\frac{\text{5400(Engine RPM)}}{\text{2(Gear Ratio 2:1)}} \times \frac{\text{13"(Prop. Dia.)}}{\text{2 (convert to radius)}} \times .7}{\text{168 (Constant for unit conversion)}} = 73.1\text{MPH}$$

Theoretical Boat Speed Equation:

$$\text{Theoretical Boat Speed (MPH)} = \frac{\text{Prop Pitch (in.) x RPM Prop}}{1056}$$

The equation applied to example boat:

$$\text{Theoretical Boat Speed (MPH)} = \frac{\text{19"+1" (pitch + cup)} \times \frac{\text{5400 (Engine RPM)}}{\text{2 (Gear Ratio)}}}{\text{1056 (Constant)}} = 51.1\text{MPH}$$

Using some basic trigonometry, the angles and blade velocity come out as shown and

$$\text{SLIP (\%)} = \left[1 - \frac{\text{Actual Boat Speed (MPH)x1056}}{\text{Prop Shaft RPMxProp Pitch (in.)}}\right] \times 100 =$$

$$\left[1 - \frac{43.5 \times 1056}{2700 \times 20}\right] \times 100 = 15\%$$

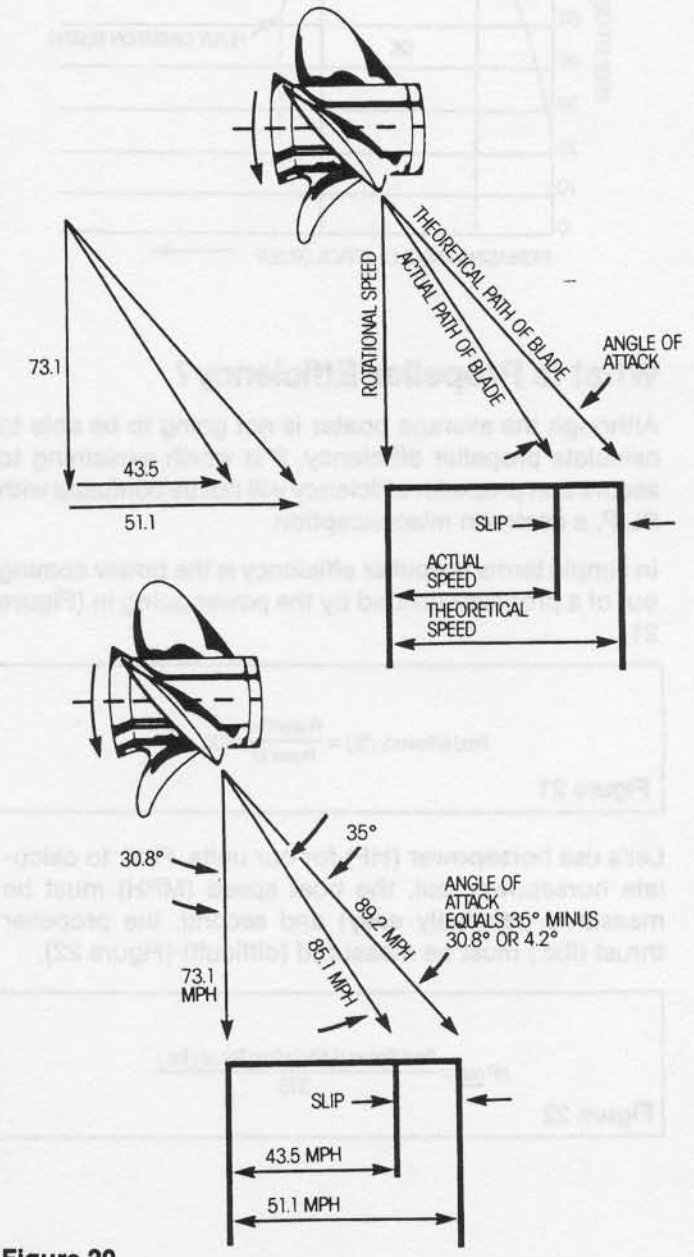
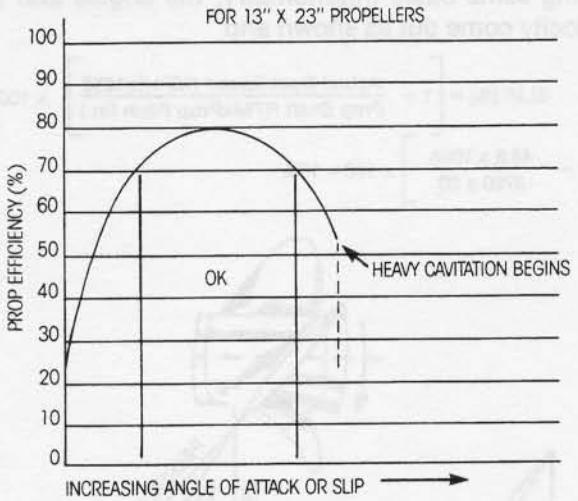


Figure 20

This graph depicts how propeller efficiency increases and, then, decreases as angle of attack is increased. In this example, efficiency peaks at approximately 80%, (3° - 4° angle of attack) and begins to decline as angle of attack increases beyond the optimum.

In a given propeller series, maximum efficiency decreases as pitch decreases. For example, a 23" pitch propeller with 13-1/2" diameter can have a peak efficiency of 80%, but a 13" pitch propeller with a 16" diameter can have a peak efficiency of only 65%.



What Is Propeller Efficiency?

Although the average boater is not going to be able to calculate propeller efficiency, it is worth explaining to assure that propeller efficiency will not be confused with SLIP, a common misconception.

In simple terms propeller efficiency is the power coming out of a propeller divided by the power going in (Figure 21).

$$\text{Prop efficiency (\%)} = \frac{\text{Power Out}}{\text{Power In}} \times 100$$

Figure 21

Let's use horsepower (HP) for our units. First, to calculate horsepower out, the boat speed (MPH) must be measured (relatively easy) and second, the propeller thrust (lbs.) must be measured (difficult) (Figure 22).

$$\text{HP out} = \frac{\text{Boat Speed (MPH)} \times \text{Prop Thrust (lbs.)}}{375}$$

Figure 22

To calculate horsepower in, the propeller shaft (RPM) must be measured (easy). Next, the propeller shaft torque (lb. ft.) must be measured (difficult) (Figure 23).

$$\text{Propeller Shaft Speed (RPM)} = \frac{\text{Engine Speed (RPM)}}{\text{Gear Reduction}}$$

$$\text{HP in} = \frac{\text{Propeller Shaft Speed (RPM)} \times \text{Propeller Shaft Torque (lb. ft.)}}{5250}$$

Figure 23

Notice that although all the characteristics of a propeller, diameter, pitch, number of blades, rake, even slip may affect efficiency indirectly, none appear in the efficiency calculation. For example, consider our 16' boat powered by a 115 HP engine (2:1 gear reduction) which runs 43.5 MPH while the engine turns 5400 RPM.

With sophisticated instrumentation the propeller shaft torque is measured to be 214 lb. ft. and the propeller thrust at 43.5 MPH is found to be 760 lbs. (Figure 24).

$$\text{The propeller shaft RPM} = \frac{\text{Engine RPM}}{\text{Gear Reduction}} = \frac{5400}{2} = 2700 \text{ RPM}$$

$$\text{Now HP out} = \frac{43.5 \times 760}{375} = 88.2 \text{ HP}$$

$$\text{HP in} = \frac{2700 \times 214}{5250} = 110.1 \text{ HP}^*$$

$$\text{Prop Efficiency} = \frac{88.2}{110.1} \times 100 = 80\%$$

Figure 24

H.P. in can often be approximated by reducing the advertised horsepower by about 5% to cover gearcase internal friction and water pump driving losses.

Example: 115 HP (.05 x 115 = 109.3 HP)

An easy-to-use, special slide rule designed specifically to calculate propeller slip is available from: **Quicksilver Division, 1939 Pioneer Road, Fond du Lac, Wi 54935, Attn: Publications Dept.** Order Part Number C-90-86147.

Materials And Construction

Stainless Steel (QSS)

The greatest advantage to using Quicksilver stainless steel propellers is their tremendous strength (Figure 1). The strength of stainless steel propellers will help maintain, if not improve, Power Package performance because they are resistant to the typical accumlation of small nicks and bends normally found on aluminum props after running for a short period of time. We use the finest stainless steel available because it provides the maximum combination of strength - about five times that of aluminum - and superb corrosion resistance. The stainless steel alloy used in Quicksilver props doesn't require cover-up coatings that soon wear away and do not enhance performance.

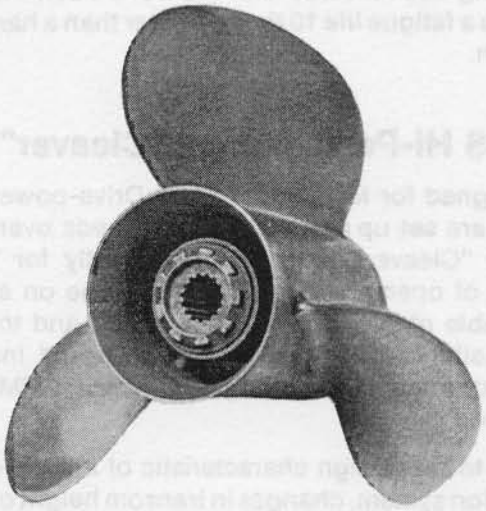


Figure 1

Aluminum

Aluminum is by far the most popular propeller material used today for stern drives (Figure 2). It is relatively low in cost, has good strength, good corrosion resistance and is easily repaired. Most Quicksilver aluminum propellers are produced by the die-cast rather than sand-cast method.

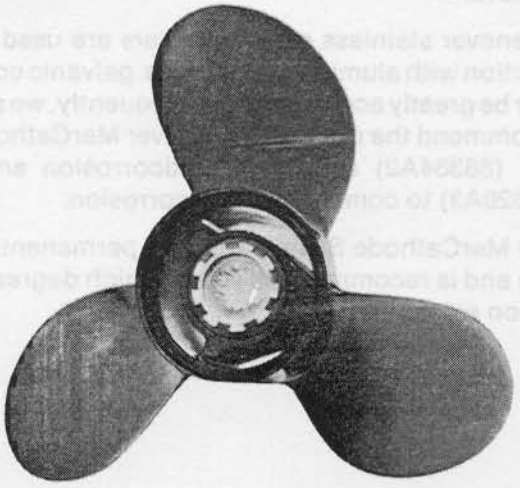


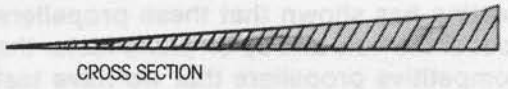
Figure 2

This is important, because die casting consistently produces propellers that more accurately duplicate the master prop. The die-cast propeller requires a minimum of machining and buffing prior to final painting. In addition, more sophisticated designs can be duplicated far more accurately with the die casting method. For instance, blade cupping is now die-cast in the blades.

For added corrosion resistance, all Quicksilver aluminum propellers are protected with a quality, durable paint. Propellers are iridite-etched to provide better paint adhesion. A thermo set epoxy paint system is applied by an eltrodeposition process as the final coating.

Cleaver

"Cleaver" is a name applied for many years to a propeller whose blades have their trailing edge cut on a straight line (Figure 3), generally on a rake line (a line passing through the center of the prop hub). Often accompanying this blade shape is a blade cross section that looks more or less like a wedge; that is, the leading edge is very thin and sharp while the trailing edge is the thickest point. This style is best suited for elevated installations which allow the propeller blades to break the water surface.



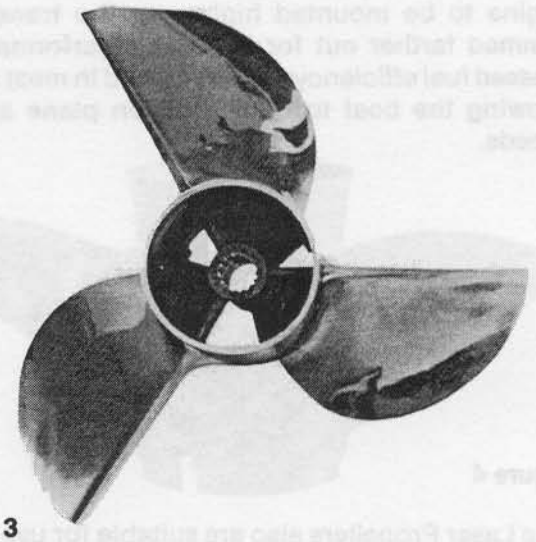


Figure 3

Stainless Steel Application

A frequent question boaters ask is "How much faster will I go if I install a stainless steel propeller, and which one should I use?"

These boaters automatically associate stainless steel propellers with greater speed and, in some applications, they are correct. However, few, if any, realize that increased speed with a stainless steel propeller usually entails more than just removing their three-blade aluminum propeller and installing a stainless steel version.

Increased speed and performance, in most cases, are usually only attainable by making changes in the stern drive installation, specifically, increasing its height on the transom and determining the proper trim or tilt angle.

Laser

The Laser Propellers (Figure 4) can be used on Mercury/Mariner V-6 outboards as well as MerCruiser I Stern Drives. These propellers were specifically designed for use on outboard equipped bass boats which have the engine mounted approximately 24" high on the transom. They provide an excellent combination of top speed, acceleration and holding ability. Our testing has shown that these propellers get the boat out of the hole and up on plane faster than any of the competitive propellers that we have tested. The excellent holding ability of these propellers allows the engine to be mounted higher on the transom and trimmed farther out for increased performance. Increased fuel efficiency also is realized in most cases by allowing the boat to remain up on plane at slower speeds.

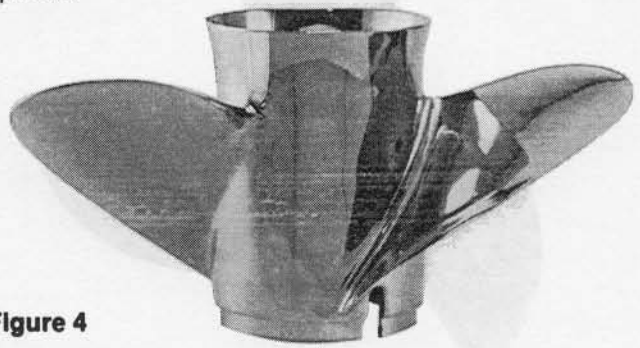


Figure 4

The Laser Propellers also are suitable for use on stern drive equipped sport boats, which require bow lift and have the stern drives mounted 1 to 2 inches higher than normal on the transom. On these applications, the Laser wil provide a nice balance of top speed and acceleration. The Laser can be used on stern drives up to 370 horsepower.

On hi-performance boats, which have the stern drives mounted high on the transom (and top speed is the major concern), the Cleaver Propellers will still usually work the best.

The Laser Propeller is of the Jet Prop™ exhaust design and is made of a corrosion resistant stainless steel alloy for maximum strength. A square rubber drive hub is employed to absorb shock when shifting, or if propeller should hit an underwater object.

Special acceleration slots are cast into the Laser Propeller. These slots improve acceleration by allowing a controlled amount of exhaust gases to be drawn into the propeller blades during acceleration. This unloads the propeller, allowing the engine to reach the higher RPM range more quickly, where it develops more horsepower.

A new Dura-Tech™ finishing process is used to polish the Laser. In addition to providing a better looking finish, the new polishing operation eliminates small scratches which could cause a fatigue failure. Our testing has revealed that the Dura-Tech™ finish provides a fatigue life 10 times greater than a hand ground finish.

QSS Hi-Performance "Cleaver"

Designed for MerCruiser Stern Drive-powered boats that are set up and capable of speeds over 50 MPH. QSS "Cleaver" propellers are strictly for "Surface" type of operation only. To install one on a boat not capable of this higher speed range, and to bury the propeller underwater, as in a standard installation, could noticeably reduce performance, RPM and boat speed.

Due to the design characteristic of a stern drive propulsion system, changes in transom height of the drive unit cannot be made easily, and usually not by the owner. Height changes required removal of the the engine and stern drive and recutting of the outdrive transom cutout hole. As a general rule, if the boat is designed to run at speeds above 50 MPH, the boat manufacturer will have mounted the engine and stern drive at the proper height and equipped the boat with the correct propeller, including a QSS stainless steel "Cleaver".

Whenever stainless steel propellers are used in conjunction with aluminum drive units, galvanic corrosion may be greatly accelerated. Consequently, we strongly recommend the use of a Quicksilver MerCathode System (88334A2) or a large anticorrosion anode kit (71320A3) to combat galvanic corrosion.

The MerCathode System will give permanent protection and is recommended where a high degree of corrosion exists.

How To Read A Selection Chart

Quicksilver propellers are designed with the correct pitch, rake, contour, blade area and diameter to give peak performance and increased fuel economy from MerCruiser Stern Drives.

The propeller charts include a boat speed range that is directly related to gross weight and boat length. The interrelation of these factors has a marked effect on the speed and performance of boats that fall within any given category. Generally, gross weight is the major factor (total weight of the entire package - boat, power package, fuel, passengers and miscellaneous equipment) and, when choosing a propeller, this should be the primary consideration.

For example, the gross load of a 24 ft. boat package equipped with a MerCruiser 120MR Stern Drive is 2750 lbs. To find the proper propeller, refer to the Propeller Selection Chart in the "Quicksilver Parts and Accessories" catalog for the power package and locate this gross load in the chart. The chart indicates that a 15 in. or 14 in. pitch propeller has a gross load range of 2300-3100 lbs. Therefore, a 14 in. pitch aluminum, or a 15 in. pitch aluminum or stainless steel should be selected.

When a propeller is matched to actual gross weight, the boat speed and full-throttle engine RPM usually will fall within the stated range. Best all-around performance is achieved when the engine runs near the top of (but within) specified full-throttle operating range. Propeller lines normally are designed so that the next size pitch will change engine RPM by 300 to 500. If the engine RPM falls, for example, too low on your first propeller selection, try a lower pitched propeller to bring the RPM up. (Higher pitched propellers reduce engine RPM).

	Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt. (Lbs.)	Approx. Boat Length	Speed Range (mph)	Propeller Part Number
MerCruiser 120R&MR	13-3/8"	25"	3	Alum.	1600-2000	Up to 17'	40-48	C-48-78126A4
	13-3/8"	25"	3	S. Steel	1600-2000	Up to 17'	40-48	C-48-79796A4
	13-1/2"	23"	3	Alum.	1700-2100	Up to 18'	37-45	C-48-78124A4
	13-1/2"	23"	3	S. Steel	1700-2100	Up to 18'	37-45	C-48-75724A4
	13-3/4"	21"	3	Alum.	1800-2200	Up to 19'	34-42	C-48-78122A4
	13-3/4"	21"	3	S. Steel	1800-2200	Up to 19'	34-42	C-48-73982A4
	14"	19"	3	Alum.	1900-2300	17'-21'	30-38	C-48-78120A4
	14"	19"	3	S. Steel	1900-2300	17'-21'	30-38	C-48-73980A4
	15-1/2"	18"	3	Alum.	1900-2300	17'-21'	29-37	C-48-11324A4
Black Max Props Thrust Hub: 77987	14-1/2"	17"	3	Alum.	2100-2600	19'-23'	25-33	C-48-78118A4
	14-1/2"	17"	3	S. Steel	2100-2600	19'-23'	25-33	C-48-79794A4
	15-3/4"	16"	3	Alum.	2100-2600	19'-23'	24-32	C-48-11322A4
	15-1/4"	15"	3	Alum.	2300-3100	21'-25'	16-27	C-48-78116A4
	14-1/2"	15"	3	S. Steel	2300-3100	21'-25'	16-27	C-48-93272A4
	16"	14"	3	Alum.	2300-3100	21'-25'	15-26	C-48-11320A4
	16"	13"	3	Alum.	2600-3600	23'-27'	6-18	C-48-78114A4
	16"	11"	3	Alum.	3000 Plus	24 Plus	To 8	C-48-78112A4
As inventory is depleted, the following MCM I propellers will be superseded by the above Black Max propellers.								
MerCruiser 120	14 1/2"	25"	3	Alum.	1600-2000	Up to 16'	39-47	C-48-79580A4
	13 1/2"	25"	3	S. Steel	1600-2000	Up to 16'	41-49	C-48-88446A4
	15"	23"	3	Alum.	1700-2100	Up to 17'	36-43	C-48-79578A4
	13 1/2"	23"	3	S. Steel	1700-2100	Up to 17'	38-45	C-48-88444A4
	15 1/4"	21"	3	Alum.	1800-2200	16'-18'	33-39	C-48-79576A4
	13 3/4"	21"	3	S. Steel	1800-2200	16'-18'	35-41	C-48-88442A4
	15 1/2"	19"	3	Alum.	1900-2300	18'-21'	29-35	C-48-79574A4
	14"	19"	3	S. Steel	1900-2300	18'-21'	31-37	C-48-88440A4
	15 3/4"	17"	3	Alum.	2100-2600	19'-23'	24-31	C-48-79572A4
MCM I Props Thrust Hub: 56292A2	14 1/2"	17"	3	S. Steel	2100-2600	19'-23'	25-32	C-48-88438A4
	16"	15"	3	Alum.	2300-3100	21'-25'	14-25	C-48-79570A4
	16"	13"	3	Alum.	3100 Plus	23' Plus	2-15	C-48-79568A4
MerCruiser 140R&MR	13-3/8"	25"	3	Alum.	1700-2200	Up to 17'	42-51	C-48-78126A4
	13-3/8"	25"	3	S. Steel	1700-2200	Up to 17'	42-51	C-48-79796A4
	13-1/2"	23'	3	Alum.	1900-2400	Up to 18'	40-48	C-48-78124A4
	13-1/2"	23"	3	S. Steel	1900-2400	Up to 18'	40-48	C-48-757
	13-3/4"	21"	3	Alum.	2100-2600	Up to 19'	37-44	C-48-7
	13-3/4"	21"	3	S. Steel	2100-2600	Up to 1	37-44	C-4
	14"	19"	3	Alum.	2300-2900	17'-2		
	14"	19"	3	S. Steel	2300-2900			
	15-1/2"	18"	3	Alum.	0-2900			
Black Max Props Thrust Hub: 77987	14-1/2"	17"	3	Alum.	2			
	14-1/2"	17"	3	S. Steel				
	15-3/4"	16"	3	Alum				
	15-1/4"	15"	3					
	14-1/2"	15"	3					
	16"	14"						
	16"							

As inv

MerCru

Propeller/Boat Matchup

Water Skiing

To take advantage of as much of the engine's horsepower as possible for pulling up water skiers, a propeller with a lower pitch should be selected. With higher initial engine RPM, more thrust is developed to pop skiers out of the water and get the boat on plane faster. Each 2" drop in pitch provides about 10% more thrust.

It's important that the operator watches the tachometer to make sure that the engine RPM does not continuously exceed the maximum specified full-throttle RPM without a skier. Propping the engine above the maximum specified RPM limit is called "under-propping".

Cruising

Since cruising does not require top acceleration, a little added fuel economy, less engine wear, and a lower sound level can be gained by selecting a higher pitched propeller. Here the engine can be propped out at the low end of the specified maximum engine RPM range. Most engines burn less fuel per horsepower at this lower RPM end than at the higher RPM end of the specified range. Here again the tachometer must be checked to be sure that, with a maximum load, the engine is not pulled below the bottom of the RPM range, or "over-propping" occurs. This can cause engine-damaging detonation.

One reason for getting better fuel economy is that propellers tend to have a slight increase in efficiency as the pitch is increased within a given prop line.

Bass Boating

Bass boats have become a very significant and very specialized breed. Designed to fit the every need of the serious fisherman, these boats tend to be narrow for their length, making them more difficult to plane off. This problem is further complicated by the considerable convience equipment carried and the weight of one or two filled live wells on the trip home. The result is that careful propping at the top of the RPM range is essential for best overall performance.

Sport Boating

When a compromise between wide-open-throttle speed and acceleration is needed, propping out in the upper half of the specified RPM range with a light load is suggested.

This should be the best prop, unless planing off with a heavy load is unsatisfactory, in which case dropping to the next lower pitch should solve the problem. But, again, it is important to watch top RPM.

Workboats

This specialized class of boats - such as pontoon boats and houseboats - use larger-diameter, low-pitch, lower-rake propellers with large blade surface areas. Here durability generally is more significant than top speed.

With lower water velocity, it is important to keep the propeller low in the water to avoid ventilation of surface air around the antiventilation plate via little whirlpools. It is imperative here to run the highest possible pitch that will satisfy all engine and usage requirements since the basic efficiency of low-pitch propellers is steadily dropping off as the pitch/diameter ratio declines.

What Is "Trim Angle" Of The Sterndrive?

Trim angle of stern drive is how far in or out from the transom surface the lower unit is tilted.

The trim angle of the lower unit has a distinct effect on the planing angle of the boat which, in turn, significantly alters top speed and handling.

What Is Power Trim?

Trimming can be controlled far more conveniently by Power Trim which is standard on MerCruiser Stern Drives. Power Trim permits control of the angle of the drive unit relative to the transom merely at the touch of a button. While on plane, the angle of the boat bottom to the water has much to do with maximum top speed, fuel economy, handling and choppy water ride.

Boat bottoms have the least drag at an angle of from 3° to 5° with the water. If they run flatter than 3°, as most light planing boats tend to do, or steeper than 5°, as stern-heavy boats just barely on plane may do, efficiency suffers.

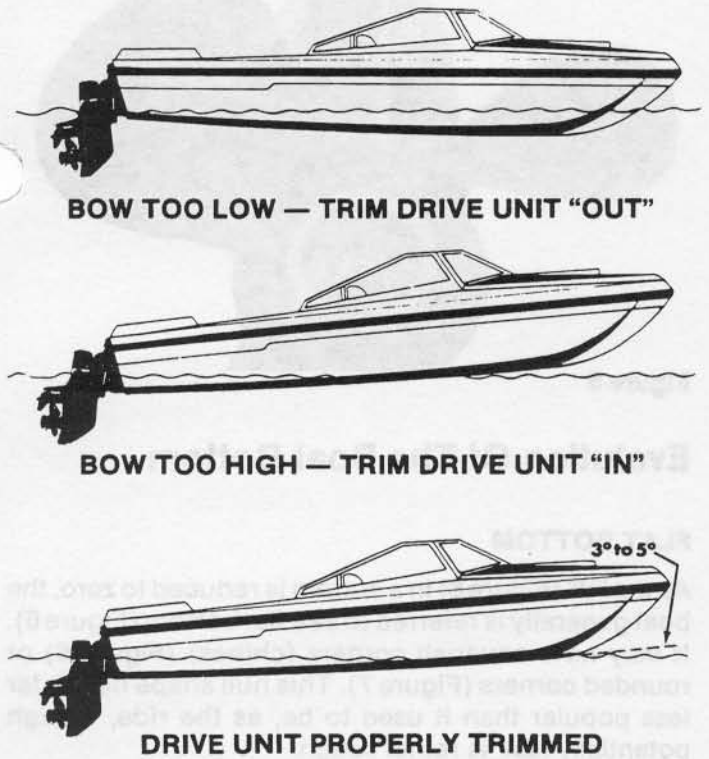
Trim Angle And Its Effect On The Boat

If trimmed "In" too far (Figure 1): Top speed drops, fuel economy decreases, the boat may oversteer in one direction or the other, called "bow steering", and steering torque will increase. Occasionally, extreme trim "under" can cause a boat to list badly to the left (with right-hand prop).

Getting on plane should be easier with some V-bottom hulls. The ride in choppy water, on plane, at part throttle should be smoother.

If trimmed "Out" too far (Figure 1): Propeller may lose its hold on the water; fast V-bottom may start to "walk" from right to left to right, etc; steering torque will increase in the opposite direction to that when trimmed "In" (Figure 1), and getting on plane may be difficult or labored. Porpoising of the boat may also occur.

It is not considered wise to operate on plane when trimmed beyond the maximum "trim" position, as the drive unit no longer receives side support from the gimbal ring. Severe damage could occur if the lower gear housing should strike a submerged object.



BOW TOO LOW — TRIM DRIVE UNIT "OUT"

BOW TOO HIGH — TRIM DRIVE UNIT "IN"

DRIVE UNIT PROPERLY TRIMMED

Figure 1

How Does Trim Angle Affect Steering Torque?

When the propeller is run fully submerged and with the propeller shaft approximately horizontal (parallel) to the surface of the water, as shown in Figure 2, there should be little (if any) steering load. Although this also applies to stern drives, there are other complications due to a stern drive's tilted steering axis which can independently cause steering torque.

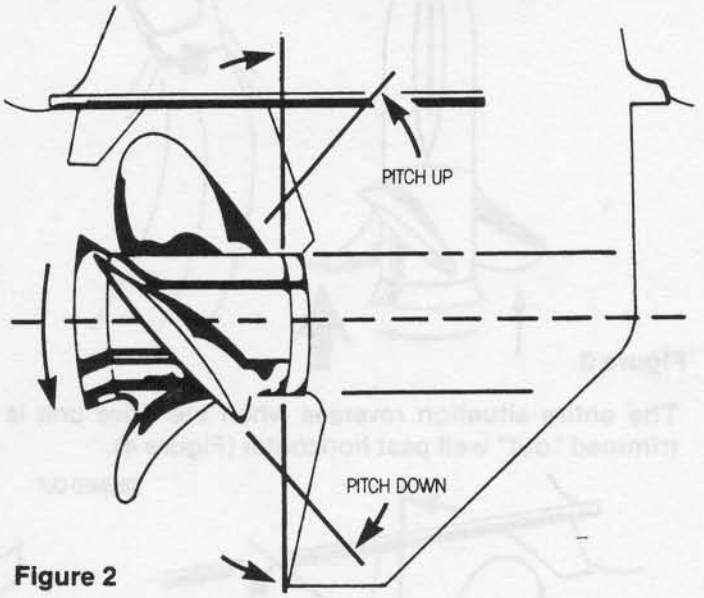


Figure 2

However, with the drive unit (RH rotation propeller) trimmed "in", as in Figure 3, because of the propeller shaft tilt, the downward-moving blade on the right side of the propeller shaft has effectively more pitch, while the opposite is true of the upward-swinging blade on the left side. This right/left imbalance pulls the drive unit to the right and, thus, makes the boat want to go into a right-hand turn. Naturally, the driver must resist this force if the boat is to continue in a straight line.

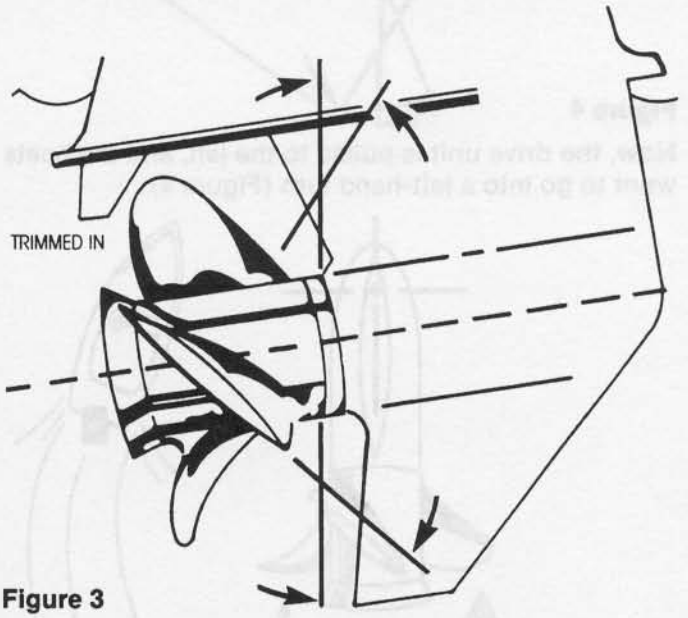


Figure 3

Figure 3 depicts the lower gear housing and propeller of the trimmed "In" drive unit as viewed from the surface of the water. Notice that the propeller blade on the right side produces more thrust than the blade on the left (indicated by different-size arrows), and that the boat is actually being pulled into a right turn.

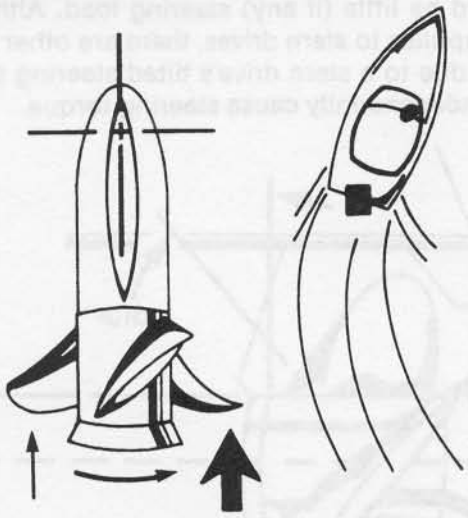


Figure 3

The entire situation reverses when the drive unit is trimmed "out" well past horizontal (Figure 4).

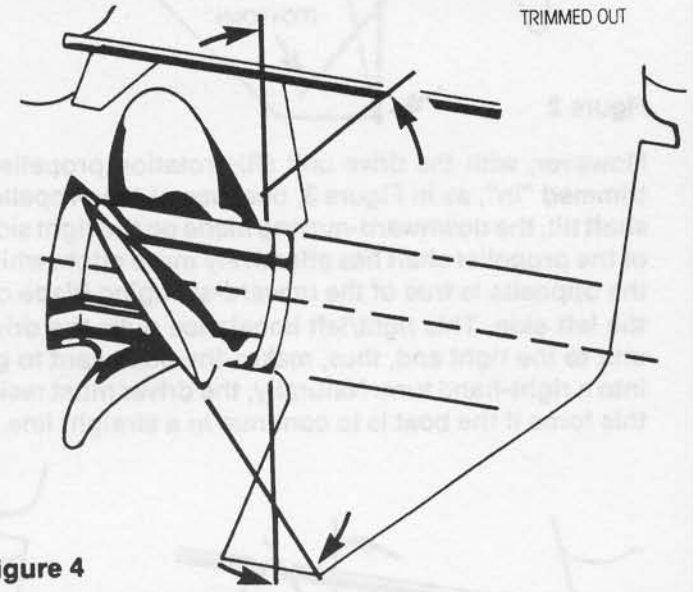


Figure 4

Now, the drive unit is pulled to the left, and the boats want to go into a left-hand turn (Figure 4).

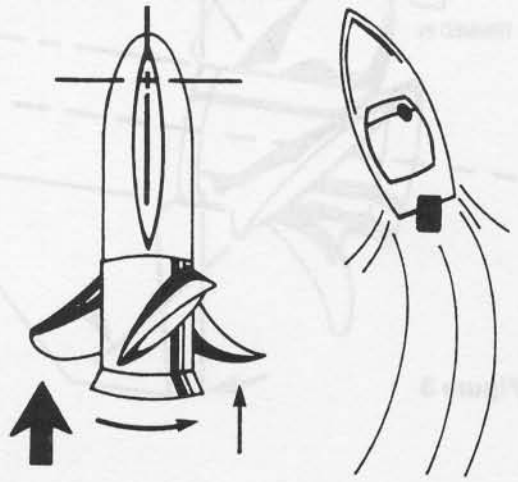


Figure 4

To help counteract this steering imbalance, all MerCruiser Stern Drives are equipped with an adjustable trim tab. Since the tab must be set in one selected position, the driver must choose the trim position that he desires to balance (Figure 5)

In most installations the drive unit will be operated in a slightly trimmed "Out" position. As explained previously, this will move the stern of the drive unit to the left, causing the boat to turn to the left. The trim tab, if properly adjusted, can steer the drive unit back in line, if in this case, the trailing edge of the trim tab is moved to the left as in Figure 5. For right-hand steering torque the opposite is true.

As a majority of MerCruiser Power Packages are equipped with Power Steering, the trim tab is set with its trailing edge straight back.

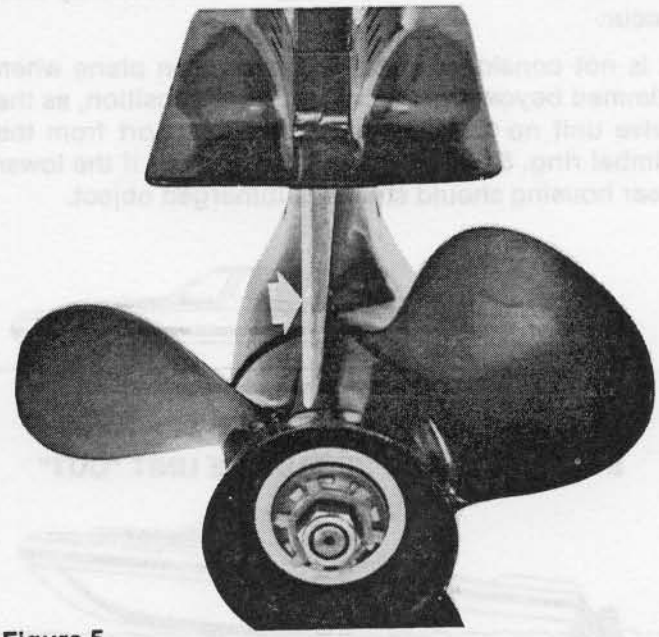


Figure 5

Evolution Of The Boat Bottom

FLAT BOTTOM

As the "V" (Figure 8) in a bottom is reduced to zero, the boat generally is referred to as a flat bottom (Figure 6). It may have squarish corners (chines) (Figure 6) or rounded corners (Figure 7). This hull shape now is far less popular than it used to be, as the ride, though potentially fast, is rather rough.

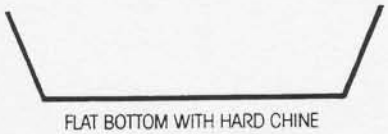


Figure 6

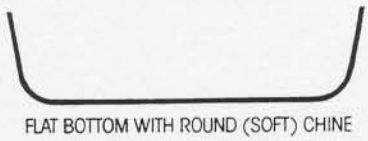


Figure 7

"V" BOTTOM

This is presently the most common bottom design (Figure 8), offering good speed with a soft ride that depends upon the angle of the "V" (called deadrise), the radius of the keel line, and the use of strakes. To increase top speed with only a little loss of softness in the ride, some boats are made with a small flat at the very bottom called a "pad" (Figure 8A).

Each boat manufacturer chooses how many and how far back (toward the transom) to bring each strake in order to achieve desired performance characteristics.

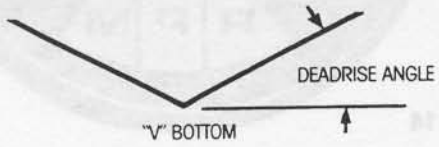


Figure 8

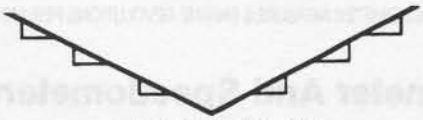


Figure 8A

TRI-HULL & CATHEDRAL HULL

These hulls usually are "V" bottoms with some degree of added outside hull, often most predominant near the bow (Figure 9). The benefit is a boat that is more stable, particularly at rest. The penalty is a rougher ride in choppy water.

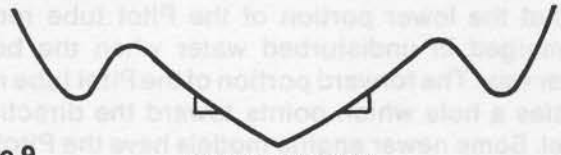


Figure 9

TUNNEL BOTTOM

This is a rather new shape to come out commercially and is most popular in racing circles. It differs from the older catamaran bottom (Figure 10) in that the inside corners (between the bottom and the tunnel) are quite sharp (Figure 10A). This allows incredible sharp high-speed turns and a very soft ride. Some of these hulls have experienced handling problems at low speeds.

Figure 10

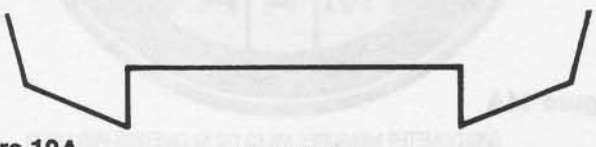


Figure 10A

TUNNEL VEE

The latest new shape (Figure 11) combines a shallow "V" bottom with twin tunnels, one on either side of center pad. Top-end performance is usually superior to true "V" bottom, but rough water handling characteristics are reduced.

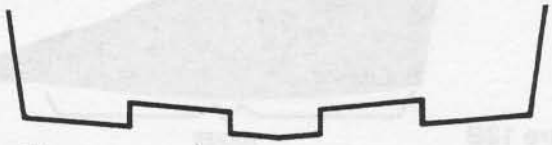


Figure 11

Is The Condition Of The Boat Bottom Important?

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5m) (Figure 12). For best speed and minimum spray the corner between the bottom and the transom should be sharp.

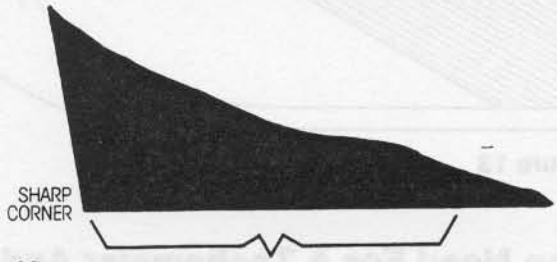


Figure 12

The bottom is referred to as having a "hook" if it is concave in the fore-and-aft direction (Figure 12A). A "hook" causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed, but it helps planing and reduces any porpoising (rythmical bouncing) tendency. A slight "hook" is often built in by the manufacturer. A "hook" can also be caused by not trailering or storing the boat with support directly under the transom.

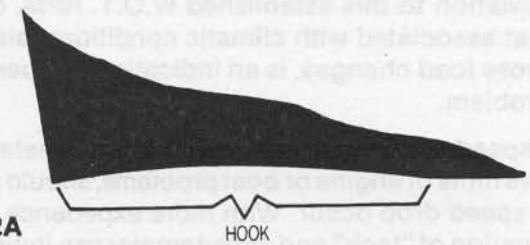


Figure 12A

A "rocker" is reverse of a "hook" (Figure 12B). The bottom is covex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.

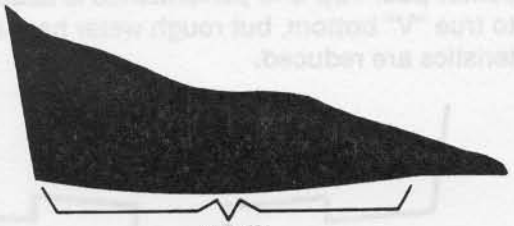


Figure 12B

Any "hook", "rocker" or surface roughness on the bottom, particularly in the all-important center-aft portion (Figure 13), will have a negative effect on speed, often several miles per hour on a fast boat.

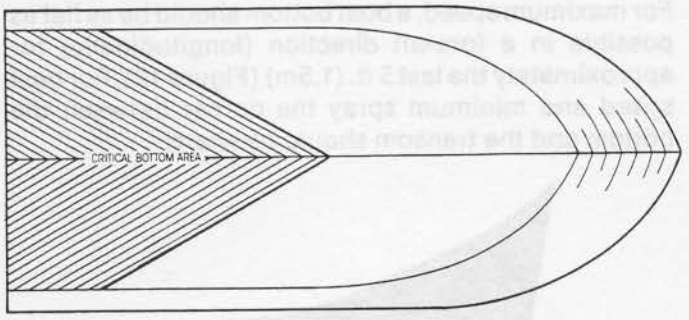


Figure 13

The Need For A Tachometer And Speedometer

The tachometer (Figure 14) measures engine RPM, while the speedometer (Figure 14A) measures boat speed in miles or kilometers per hour. An engine is designed to be run, when at wide-open throttle, within certain RPM limits. Without a tachometer, the operator has little opportunity to know if his engine is at a dangerously high or low RPM level. Once the correct propeller is selected the engine will run at wide-open throttle within the specified maximum RPM range. And deviation to this established W.O.T. RPM, other than that associated with climatic conditions, elevation, or gross load changes, is an indication of a performacne problem.

A speedometer, when used with a tachometer, also will give hints of engine or boat problems, should an unusual speed drop occur. With more experience, the combination of "tach" and speedometer can indicate problems at part throttle. For a good solid speed reading, it is important to install the speedometer pickup as low and close to the center of the boat as possible without creating water disturbance ahead of the propeller.

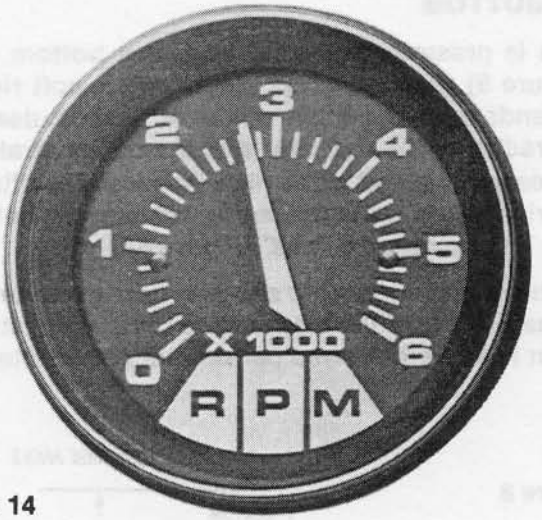


Figure 14

TACHOMETER MEASURES ENGINE REVOLUTIONS PER MINUTE.

Tachometer And Speedometers As Performance Indicators

For engineering tests extremely accurate and expensive tachometers are used. RPM information from these instruments provides unquestioned input for engineering evaluation. Tachometers commonly installed in boats are not intended to provide this same degree of accuracy. Therefore, a slight variance from the true RPM is common in these instruments.

The common type of boat speedometer consists of a Pitot tube, an instrument panel-mounted gauge which is calibrated to indicate miles per hour (MPH) and/or kilometers per hour (KPH), and the connecting tube or hose. The Pitot tube is usually mounted on the transom so that the lower portion of the Pitot tube remains submerged in undisturbed water when the boat is under way. The forward portion of the Pitot tube incorporates a hole which points toward the direction of travel. Some newer engine models have the Pitot tube built into the leading edge of the gear-housing strut.

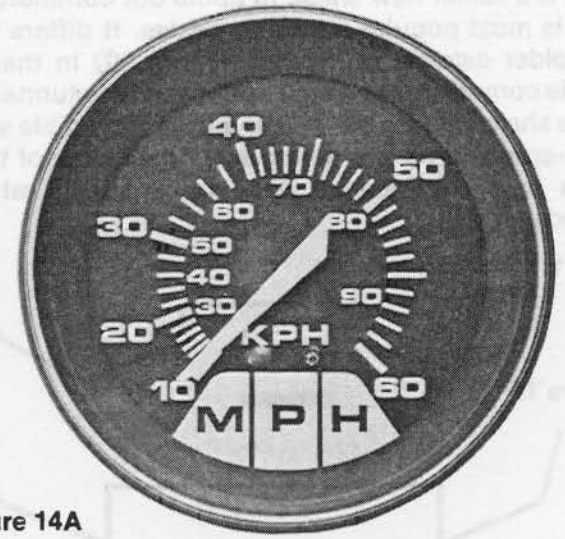


Figure 14A

SPEEDOMETER MEASURES MILES OR KILOMETERS PER HOUR.

As the boat moves forward, water enters the Pitot tube through this hole and compresses the air trapped within the connecting hose and the bellows or bourdon tube in the gauge. This air pressure, which varies in relation to the boat speed, actuates the needle movement mechanism indicating the speed of the boat. The accuracy of the speedometer may suffer from winter-freeze damage caused by trapped water in the line or instrument head, from a damaged Pitot tube, or from improper installation location. For engineering tests, common speedometers are rejected in favor of more accurate timing devices such as stop watches used on measured courses or radar speed indicators. The reason for explaining these variables is to prepare you for any unusual results that you may obtain in calculating your boat speed, propeller slip or angle of attack, when using the preceding or following equations.

How Does Elevation And Climate Affect Performance?

Elevation has a very noticeable effect on the wide-open throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air, like using a supercharger in reverse. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is dropped out on a cool, dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip. (See the accompanying HP/weather relationship chart, Figure 15.)

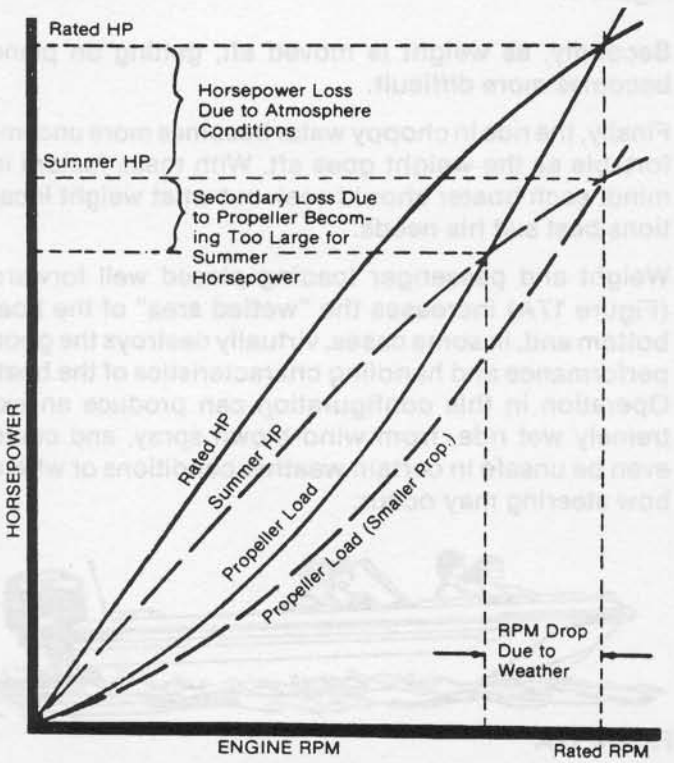


Figure 15

Although some performance can be regained by dropping to a lower-pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to more reduction is possible and very beneficial.

It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

The marine engine rating code J1228 of the Society of Automotive Engineers (SAE) standardizes the computation of horsepower from data obtained on the dynamometer, correcting all values to the power that the engine will produce at 80.6° F (27° C) temperature, relative humidity 60% and a barometric pressure of 29.53 inches (750 millimeters) of mercury.

Summer conditions of high temperature, low barometric pressure and high humidity all combine to reduce the engine power. This in turn, is reflected in decreased boat speeds - as much as 2 or 3 miles per hour in some cases. (Refer to Figure 15.) Nothing will regain this speed for the boater, but the coming of cool, dry weather.

In pointing out the practical consequences of weather effects, an engine - running on a hot, humid summer day - may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk spring or fall day. The horsepower, that any internal combustion engine produces, depends upon the density of the air which it consumes and, in turn, this density is dependent upon the temperature of the air, its barometric pressure and water vapor (or humidity) content.

Accompanying this weather-inspired loss of power is a second but more subtle loss. At rigging time in early spring, the engine was equipped with a propeller that allowed the engine to turn within its specified RPM range at full throttle. With the coming of the summer weather and the consequent drop in availiable horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its specified RPM.

Due to the horsepower/RPM characteristics of an engine, this will result in further loss of horsepower at the propeller with another decrease in boat speed. This secondary loss, however, can be somewhat regained by switching to a lower-pitch propeller that allows the engine to again run at specified RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine be propped to allow it to operate at or near the top end of the specified maximum RPM range at wide-open throttle with a normal boat load.

Not only does this allow the engine to develop full power, but equally important is the fact that the engine also will be operating in an RPM range that discourages damaging detonation. This, of course, enhances overall reliability and durability of the engine.

What Are After Or Trim Planes And What Do They Do?

They are a pair of flat, movable surfaces that extend aft from the boat bottom, one on each side of center (Figure 16). Each surface is individually adjustable up or down and, on the more sophisticated installation, by a remote control switch.

After planes offer another method of trimming your boat,in addition to Power Trim. When a boat's running attitude exceeds 5°, it is beginning to run increasingly less efficient. Therefore, stern-heavy boats that need to run at a slow plane (20-25 MPH) will be greatly aided by after planes both in the efficiency and comfort departments.

Other benefits of after planes are: Faster planing, control of list and additional fuel savings made possible by allowing the boat to run at a lower engine RPM while remaining in an efficient planing attitude.

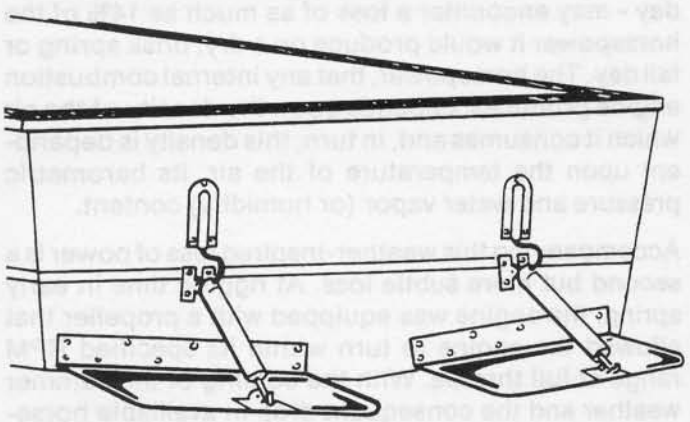


Figure 16

What Does A Chipped Or Bent Propeller Do To Boat Speed?

Even slight propeller damage can mean the loss of one MPH. Greater damage can mean considerably mor speed loss. Worse yet, damage usually is not done t each blade uniformly and, therefore, sets up imbalance vibrations that can cause fatigue damage to other parts of the engine or drive.

Up to a point, dealers can have a propeller restored to like-new condition; however, extreme damage can be more expensive to repair than the cost of a replacment. Remember to carry a spare!

How Does Weight Distribution Affect Boat Performance?

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight — fuel, battery, anchor, passengers —should be as far aft as possible (Figure 17), to allow the bow to come up to a more effecient angle (3° to 5°). But on the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

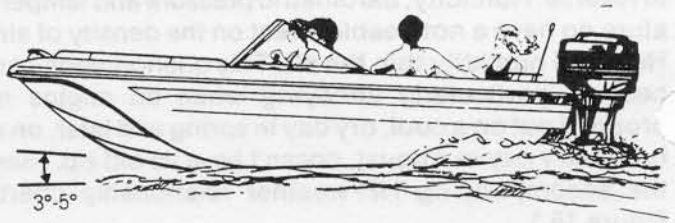


Figure 17

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his needs.

Weight and passenger loading placed well forward (Figure 17A) increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Figure 17A

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution (Figure 17B). Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

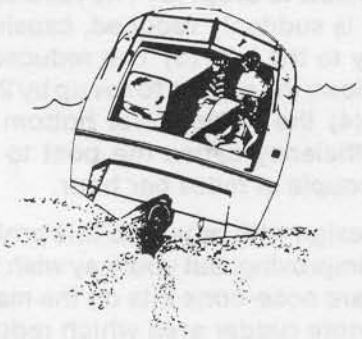


Figure 17B

Performance/Maintenance

What is Ventilation?

Ventialtion occurs when air from the water's surface or exhaust gases from the exhaust outlet are drawn into the propeller blades (Figure 1). The normal water load is reduced and the propeller over-revs, losing much of its thrust; however, as the propeller momentarily over revs, this brings on massive cavitation which can further "unload" the propeller and stop all foward thrust. It continues until the propeller is slowed down enough to allow the bubbles to surface. This action most often occurs in turns, particularly when trying to plane in a sharp turn or with an excessively trimmed-out engine or drive unit.

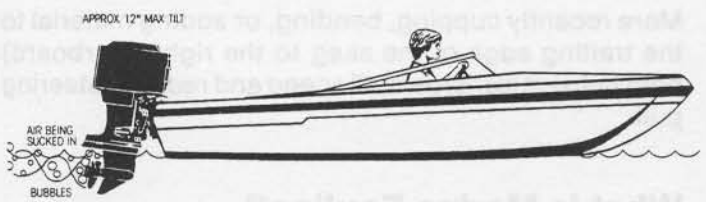


Figure 1

Stern drive units are designed with a large "anti-ventilation" plate cast integrally into the lower gear housing directly above the propeller (Figure 2). This plate is frequently and incorrectly referred to as a "cavitation" or "anti-cavitation plate". The purpose of this plate is to eliminate or reduce the possibility of air being sucked into the tips of the propeller blades from the surface.

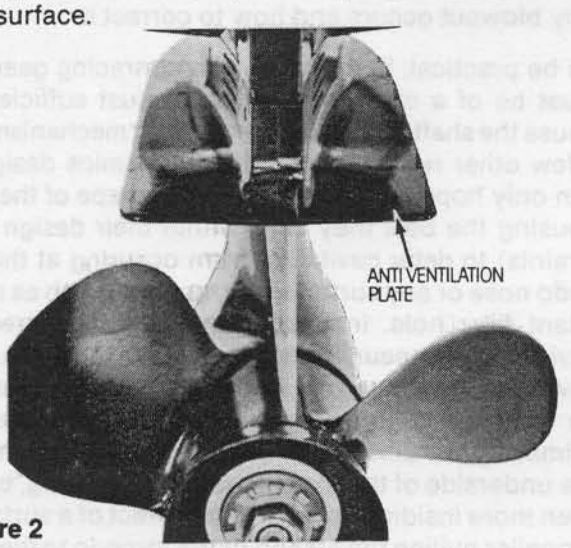


Figure 2

For improved engine and boat performance, most Quicksilver props feature a hub design with a flared trailing edge or "Diffuser Ring". This assists exhaust gas flow and provides a pressure barrier that helps prevent exhaust gases from feeding back into the blades (Figure 3). This design is vital to our Jet-Prop exhaust propeller system to get the maximum performance.

Figure 3

High-Speed Gearcase Blowout

Many high-performance boaters are aware of a phenomenon that limits their top speed below what would otherwise be possible with the available horsepower. This phenomena is commonly called "gearcase blowout" or just "blowout". Following is an explanation of why blowout occurs and how to correct it.

To be practical, the torpedo of a nonracing gearcase must be of a diameter and length just sufficient to house the shafts, gears, bearings, shift mechanism and a few other related parts. Hydrodynamics designers can only hope to make the exterior shape of the gear housing the best they can (within their design constraints) to deter cavitation from occuring at the torpedo nose or any surface interruptions, such as a lubricant filler hole. Inevitably, as speed is increased, cavitation will occur. Since low pressure is the cause of cavitation, anything that further reduces the pressure on any side of the torpedo will hasten cavitation. Trimming the unit out will cause lower pressures on the underside of the topredo, around the skeg, but an even more insidious culprit is the effect of a surfacing propeller pulling the aft end of the torpedo to the right with a right-hand rotation propeller. This causes lower pressure on the left side because of the angle which the gearcase is forced to run through the water. This is commonly called the "crab" angle (Figure 4).

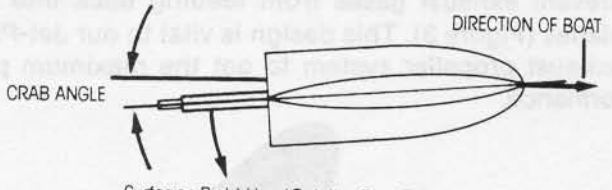


Figure 4

The typical combination of a surfacing right-hand propeller and trimming out for best speed creates an extra-low pressure pocket on the lower left side of the torpedo.

However, cavitation in itself does not cause the "blowout". Blowout occurs when the very low pressure cavitation bubbles eventually reach back to the aft end of the torpedo in sufficient quantity to suddenly pull in, or connect up with the engine exhaust gases. The cavitation and exhaust gas linkup are more prevalent with a Nonjet-Prop exhaust propeller.

Once the connection is made, the exhaust floods out over the low-pressure side of the gearcase (the left side with a right-hand rotation propeller) and feeds back into the prop blades, causing a sudden and drastic reduction of lift or thrust generated by the low pressure side of the propeller blades. This partial unloading of the propeller creates four sudden reactions: (1) The bow-lifting effect of the rake diminishes, causing the bow to drop. (2) The hard steering torque to the right is suddenly reduced, causing the boat to veer slightly to the left. (3) The reduced, load on the propeller allows the engine to rev up by 200 RPM to 300 RPM, and (4) the wetter boat bottom and reduced propeller efficiency cause the boat to go slower by perhaps a couple of miles per hour.

Gearcase design with regard to this problem has generally been improving, but you may wish to try a trick or two. There are nose-cone kits on the market that help by adding more rudder area which reduces the "crab angle" and provides a larger torpedo nose radius which reduces nose cavitation. However, the nose cones are a bit of a chore to install and may be easily damaged. Other than running with excessive trim "Out", the most significant cause of blowout is a torpedo that has been buffed in a way that rolls off the trailing edge of the torpedo (Figure 5)

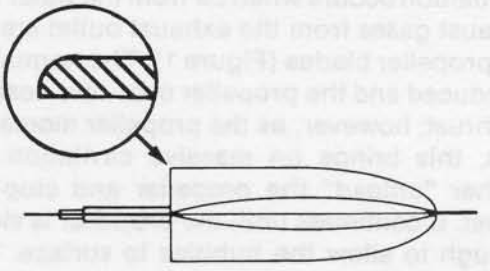


Figure 5

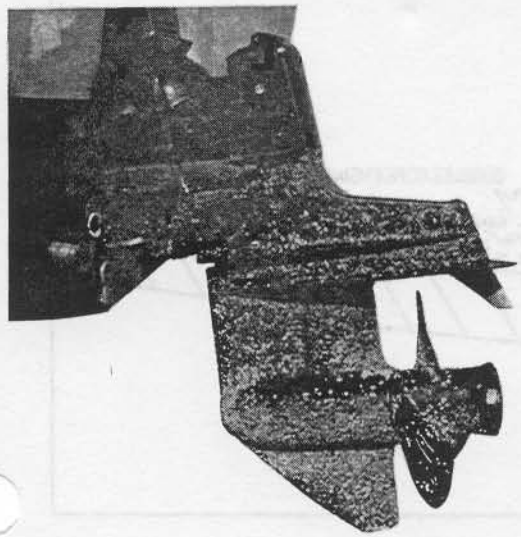
More recently cupping, bending, or adding material to the trailing edge of the skeg to the right (starboard) both helps raise "blowout" speed and reduces steering pull.

What is Marine Fouling?

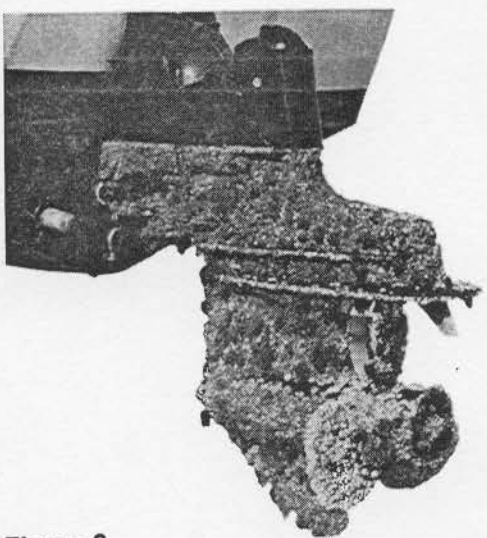
Fouling is a kind of unwanted buildup (usually animal-vegetable-derived) occurring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. So it's important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Special hull treatments, such as antifouling paint, will reduce the rate of bottom fouling. However, due to the fact that drive units are made primarily of aluminum, be sure to select an antifouling paint having a copper-free, organo-tin base. The BIS (Tri Butyl Tin) Adipate (TBTA) base paint will not set up a galvanic corrosion "cell" as it is completely compatible with aluminum and avoids any electrolysis problems connected with many other paints. Applied according to instruction, it is also very effective.

Florida test site photographs indicates the rapid growth of barnacles, algae and slime. Buildup should never be allowed to reach the stage in Figure 6, which would alread by extremely difficult to remove.

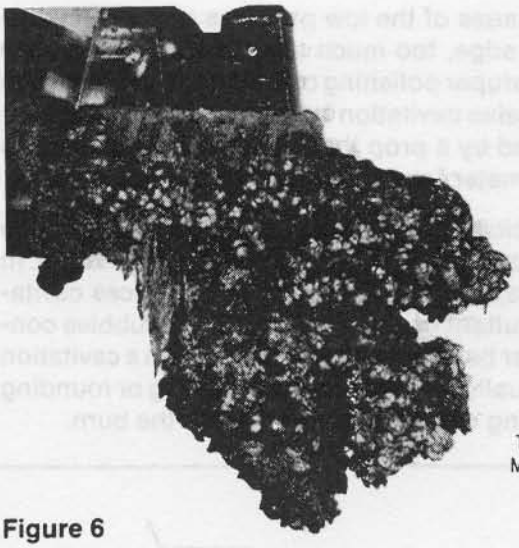


TWELVE DAYS EXPOSURE



THIRTY-SIX DAYS EXPOSURE

Figure 6



THREE AND A HALF MONTHS EXPOSURE

Figure 6

What is Cavitation?

We all know that water boils at 212° F (100° C) at normal sea-level atmospheric pressure. But water also boils at room temperature, if the atmospheric pressure is low enough.

As a shape passes through water at an increasing speed, the pressure, that holds the water to the sides and back of the shape, is lowered. Depending upon the water temperature, when the pressure reaches a sufficiently low level, boiling will begin. This occurs most often on a propeller at the leading edge of the blade. When speed is reduced and the pressure goes up, boiling will subside. As the water vapor bubbles move downstream into a higher pressure region that won't sustain boiling, they collapse (condense back to liquid). The collapsing action of the bubbles releases energy that chips away at the blades, causing a "cavitation burn" or erosion of the metal (Figure 7).

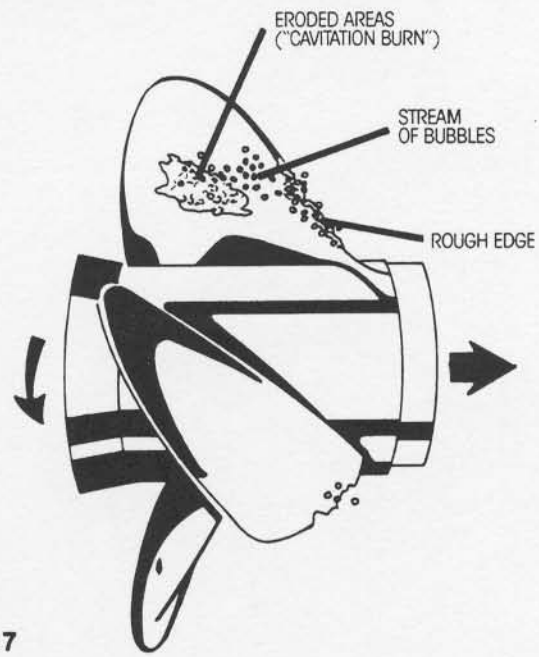


Figure 7

The initial cause of the low pressure may be nicks in the leading edge, too much cup, sharp leading edge corners, improper polishing or, sometimes, poor blade design. Massive cavitation by itself is rare, and it usually is caused by a prop that is severly bent or far too small in diameter for the engine.

Figure 8 depicts the cross section of a propeller blade which shows an example of one cause of cavitation. In this example, a sharp leading edge produces cavitation and resultant cavitation burn as the bubbles condense further back on the blade face. Such a cavitation burn can usually be corrected by repairing or rounding off the leading edge directly in front of the burn.

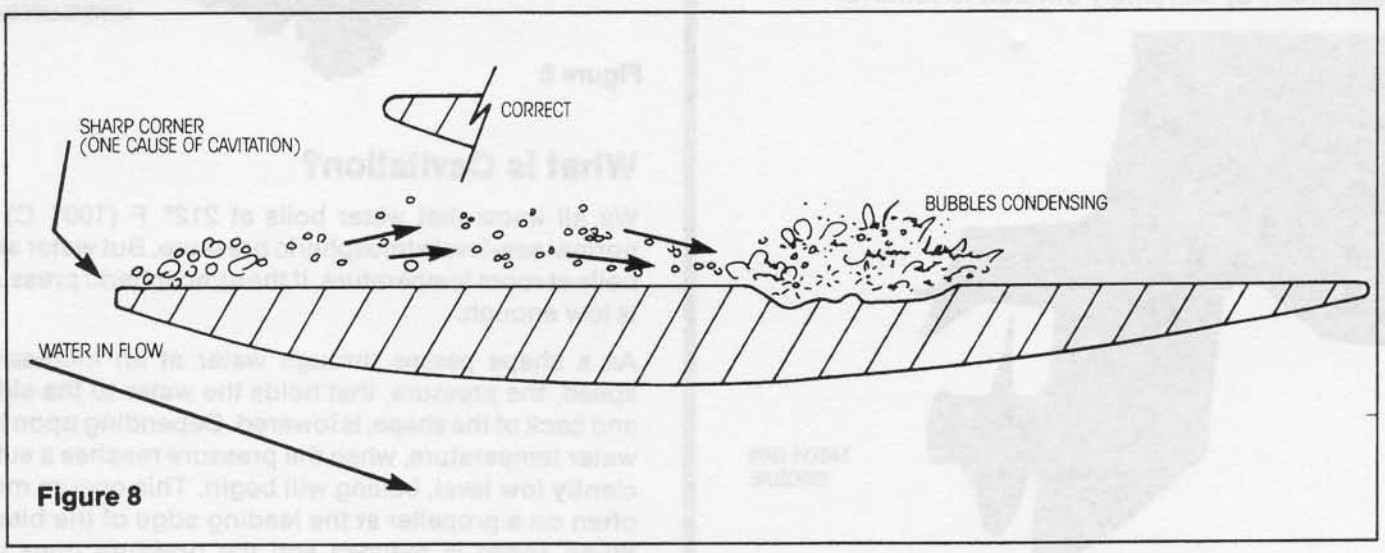


Figure 8

GENERAL INFORMATION

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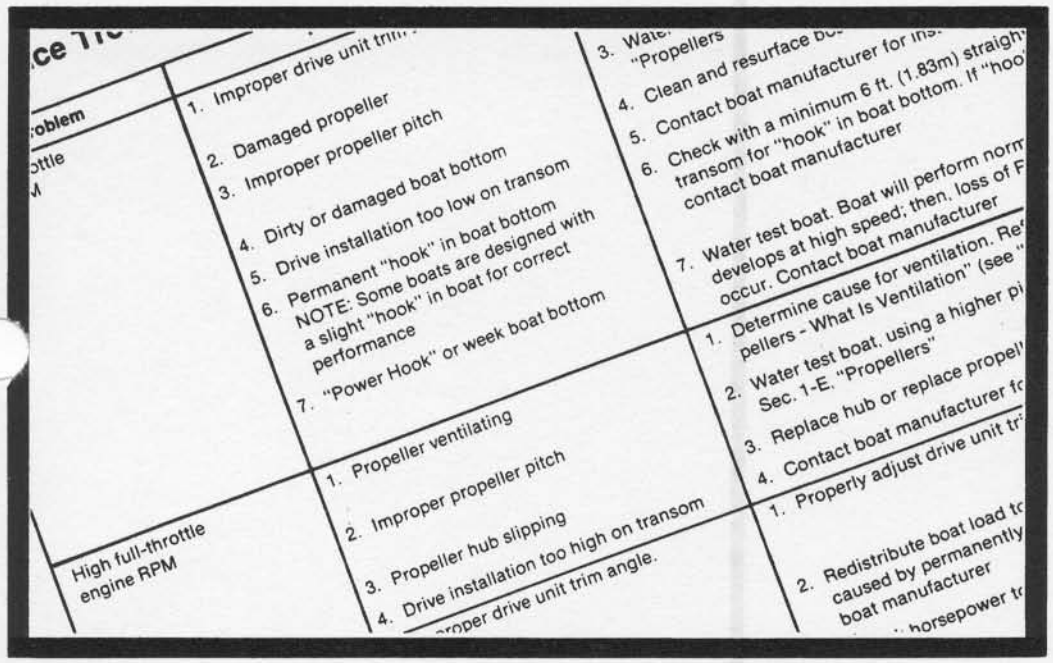

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ottle M	2. Damaged propeller	4. Clean and resurface bo...
	3. Improper propeller pitch	5. Contact boat manufacturer for ins...
	4. Dirty or damaged boat bottom	6. Check with a minimum 6 ft. (1.83m) straigh... transom for "hook" in boat bottom. If "hoo... contact boat manufacturer
	5. Drive installation too low on transom	
	6. Permanent "hook" in boat bottom NOTE: Some boats are designed with a slight "hook" in boat for correct performance	7. Water test boat. Boat will perform norm... develops at high speed; then, loss of P... occur. Contact boat manufacturer
	7. "Power Hook" or week boat bottom	1. Determine cause for ventilation. Ref... pellers - What Is Ventilation" (see "...
	1. Propeller ventilating	2. Water test boat, using a higher pi... Sec. 1-E, "Propellers"
	2. Improper propeller pitch	3. Replace hub or replace propell...
	3. Propeller hub slipping	4. Contact boat manufacturer fo...
High full-throttle engine RPM	4. Drive installation too high on transom	1. Properly adjust drive unit tri...
	...roper drive unit trim angle.	2. Redistribute boat load to... caused by permanently... boat manufacturer
		...horsepower to...

TROUBLESHOOTING

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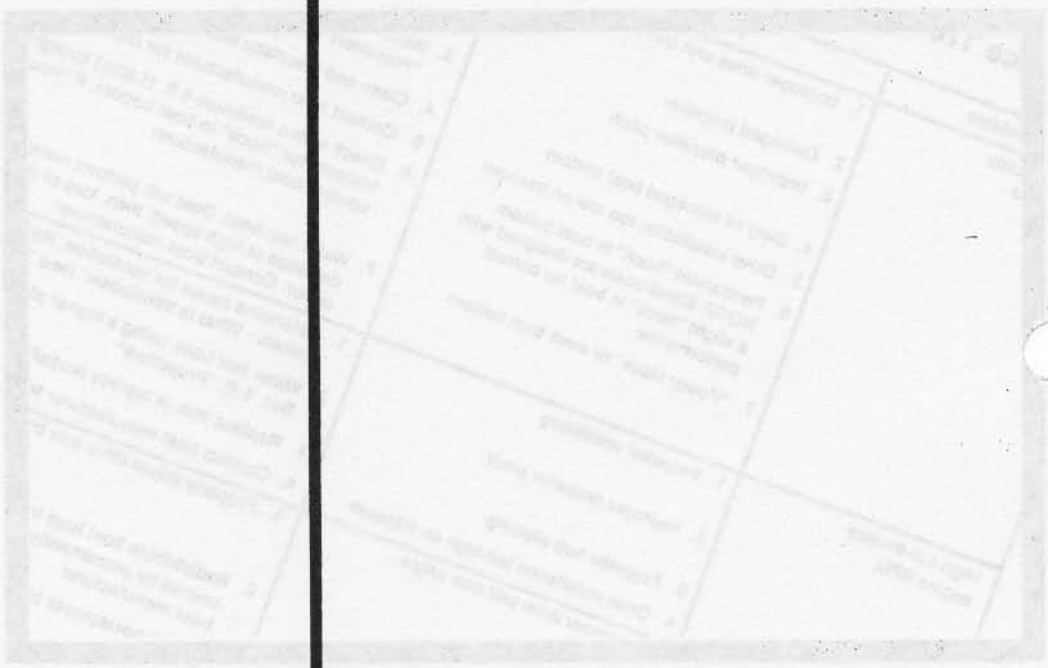


Troubleshooting

This section is a guide for performance and product troubleshooting. Referrals to specific sections of this manual are made where special tests or a repair procedure are to be performed.

Because of the relationship between Power Package components (engine and stern drive), it will be necessary, in some cases, to simultaneously refer to the appropriate MerCruiser Engine Service Manual for further troubleshooting information.

Much of this information will be familiar to the trained mechanic. Using this chart as a guide, allowing time for careful analysis, and a mechanics personal product experience will enable effective product troubleshooting.

Performance Troubleshooting

Problem	Possible Cause	Remedy
Low full-throttle engine RPM	1. Improper drive unit trim angle	1. Adjust drive unit trim angle.
	2. Damaged propeller	2. Repair or replace.
	3. Improper propeller pitch	3. Water test boat, using a lower pitch propeller. Refer to "Propellers" - Sec. 1-E.
	4. Dirty or damaged boat bottom	4. Clean and resurface boat bottom.
	5. Drive installation too low on transom	5. Contact boat manufacturer for installation specifications.
	6. Permanent "hook" in boat bottom NOTE: Some boats are designed with a slight "hook" for correct performance	6. Check with a minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If "hook" is found, contact boat manufacturer.
	7. "Power Hook" or weak boat bottom	7. Water test boat. Boat will perform normal until "hook" develops at high speed; then, loss of RPM and speed will occur. Contact boat manufacturer.
High full-throttle engine RPM	1. Propeller ventilating	1. Determine cause for ventilation. Refer to Sec. 1-E.
	2. Improper propeller pitch	2. Water test boat, using a higher pitch propeller. Refer to Sec. 1-E.
	3. Propeller hub slipping	3. Replace hub or propeller.
	4. Drive installation too high on transom	4. Contact boat manufacturer for installation specifications.
Poor boat performance and/or poor maneuverability - Bow too low	1. Improper drive unit trim angle	1. Adjust drive unit trim angle.
	2. Boat is bow heavy	2. Redistribute boat load to stern. If bow overweight is caused by permanently installed fuel tank(s), etc, contact boat manufacturer.
	3. Boat underpowered	3. Check horsepower to weight ratio, contact boat manufacturer.
	4. Permanent "hook" in boat bottom NOTE: Some boats are designed with a slight "hook" in boat for correct performance	4. Check with a minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If "hook" is found, contact boat manufacturer.
	5. "Power Hook" or weak boat bottom	5. Water test boat. Boat will perform normal until "hook" develops at high speed; then, loss of RPM and speed will occur.

Problem	Possible Cause	Remedy
Poor boat performance and/or poor maneuverability-Bow too high	1. Improper drive unit trim angle	1. Adjust drive unit trim angle.
	2. Boat is stern heavy	2. Redistribute boat load to bow. If stern overweight is caused by permanently installed fuel tank. etc., contact boat manufacturer.
	3. Improper propeller pitch - too high	3. Water test boat, using a lower pitch propeller. Refer to Sec. 1-E.
	4. Dirty boat bottom	4. Clean.
	5. "Rocker" in bottom of boat	5. Check with a minimum 6 Ft. (1.83m) straight edge from transom for "rocker" in boat bottom. If "rocker" is found, contact boat manufacturer.
	6. Propeller Ventilating/Cavitating	6. Refer to Sec. 1-E.

Stern Drive Unit Troubleshooting

Problem	Possible Cause	Remedy
Gear housing noise	1. Metal particles in drive unit lubricant	1. Dissassemble, clean and inspect, and replace necessary components. Refer to Sec. 3.
	2. Propeller incorrectly installed	2. Install propeller correctly. Refer to Sec. 1-E.
	3. Propeller shaft bent	3. Inspect and replace if necessary. Refer to Sec. 3.
	4. Incorrect gear shimming	4. Check gear housing back-lash and pinion gear height. Refer to Sec. 3-C.
	5. Worn or damaged gears and/or bearings caused by impact, overheating, or improper shimming	5. Disassemble inspect and replace. Refer to Sec. 3-C.
Drive shaft housing noise	1. Steering lever contacting transom cutout opening in turns.	1. Modify transom cutout.
	2. Propeller with untrue or out-of balance blades	2. Repair or replace, as required.
	3. Abnormal stern drive operation	3. Instruct operator on proper operating technique.
	4. U-Joint cross and bearing assembly C-Rings improperly installed or of incorrect size	4. Make sure that proper thickness C-Rings are used and that rings are fully seated in U-Joint bearing cap grooves (Sec. 3-B).
	5. Excessive side-to-side play in U-Joint cross and bearing assemblies	5. Install C-Ring Kit 53-12067A1 (Sec. 3-B).
	6. U-Joint bearing caps contacting center socket or drive shaft housing bearing retainer	6. Make sure that proper cross and bearing assemblies are being used. If interference is slight, grind off area on center socket or retainer where bearing caps are hitting. If interference is severe, replace center socket. (Sec. 3-B).
	7. U-Joint cross and bearings rough	7. Disassemble cross and bearing assemblies and inspect. DO NOT RELY ON FEEL. Replace assemblies if they show signs of scoring, galling, roughness, lack of lubricant, etc. (Sec. 3-B).
	8. O-Rings missing or flattened out on U-Joint shaft -- causing shaft to rattle against ID of gimbal bearing	8. Install new O-Rings (Sec. 3-B).
	9. Worn U-Joint shaft splines and/or engine coupler splines	9. Remove U-Joint coupling end yoke and insert into gimbal bearing and engine coupling. Rotate shaft back-and-forth. If play is excessive, replace U-Joint coupling end yoke and/or engine coupler, as necessary.

Problem	Possible Cause	Remedy
Drive shaft housing noise (continued)	10. Engine alignment incorrect	10. Adjust alignment, making sure that alignment tool moves in-and-out freely.
	11. Gimbal bearing rough	11. Replace gimbal bearing (Sec. 4). IMPORTANT: Gimbal bearing and carrier MUST BE replaced as an assembly as they are a matched set. Failure to do this may result in a loose bearing fit in carrier.
	12. Loose gimbal bearing	12. Reinstall bearing using a new tolerance ring, if carrier is loose in gimbal housing. If bearing is loose in carrier, bearing assembly must be replaced (Sec. 4).
	13. Gimbal bearing not fully seated in gimbal housing. Yoke moves back and forth in turns and may hammer against bearing if not fully seated	13. Drive bearing assembly into place. IMPORTANT: Gimbal bearing must be pressed in past lead-in chamfer in bearing bore (Sec. 4).
	14. Excessive clearance between gimbal ring and gimbal housing. This could cause misalignment between bell housing and gimbal housing and also may allow gimbal ring to vibrate up-and down in turns	14. Check and adjust clearance (Sec. 4).
	15. Stringer height uneven or transom assembly installed cocked on boat transom. This will affect engine alignment, but is usually not detectable with alignment tool	15. Measure distance between engine flywheel housing and inner transom plate on both sides. If distances are uneven, problem may be due to uneven stringer height or a a cocked transom assembly. Adjust stringer height or relocate transom cutout as required.
	16. Weak boat transom or boat bottom that flexes under power and causes engine misalignment	16. This condition can sometimes be detected by having someone force up-and-down on the drive unit while watching the inner transom plate. If movement can be observed, transom is weak and must be repaired.
	17. Rear engine mount attaching hardware improperly installed or missing	17. Reinstall hardware correctly.
	18. Improperly installed or failed rear engine mounts. This will affect engine alignment, but usually is not detectable with alignment tool	18. Check for uneven mount height or loose or soft mounts. Check to make sure that there is clearance between flywheel housing and fiber washer. If no clearance-exists, mounts have probably sagged. Install mounts correctly or replace as necessary.
	19. Engine mounting holes drilled off-center in inner transom plate engine supports	19. Check to make sure that holes are equally spaced and are equal distance from centerline.
	20. Boat transom too thin [1-3/4 in. (44mm) minimum]	20. Add thickness to transom.
	21. Boat transom thickness uneven [1/8 in. (3mm) variance maximum]. This could affect engine to transom assembly alignment and is usually not detectable with alignment tool	21. Repair boat as necessary.

Problem	Possible Cause	Remedy
Stern drive unit will not slide into bell housing	1. U-Joint shaft splines not aligned with transmission output housing splines 2. Engine not aligned 3. Gimbal bearing not properly installed 4. Damaged U-Joint shaft splines and/or transmission output housing splines.	1. Rotate propeller shaft COUNTERCLOCKWISE to align splines (Sec. 2). 2. Check engine alignment (Sec. 2). 3. Check engine alignment to determine if gimbal bearing may be cocked in gimbal housing (Sec. 2). 4. Inspect and replace if necessary.
Drive unit does not shift into gear; remote control shift handle moves	1. Shift cables improperly adjusted 2. Shift cables not connected 3. Inner core wire broken or loose 4. Transmission linkage improperly adjusted	1. Adjust shift cables (Sec. 2 and 4). 2. Install and adjust shift cables (Sec. 2 and/or 4). 3. Reconnect or replace inner core wire (Sec. 4). 4. Adjust linkage (Sec. 2)
Drive unit does not shift into gear; remote control shift handle does not move	1. Control box not properly assembled 2. Broken or damaged linkage in control box 3. Transmission linkage improperly adjusted 4. Controls improperly adjusted - Cable end guide hitting brass barrel	1. Properly reassemble (Sec. 7). 2. Repair (Sec. 7) 3. Adjust linkage (Sec. 2) 4. Adjust shift cables (Sec. 2 and/or 4).
Drive unit shifts hard	1. Shift cables improperly adjusted 2. Damaged remote control or drive unit shift cable 3. Shift cutout switch improperly adjusted or inoperative 4. Shift cable too short (sharp bends) or too long (loops and long bends) 5. Corroded shift cables 6. Internal wear in remote control box 7. Shift cable attaching nut too tight (end cannot pivot) 8. Shift cable pivot ends corroded or not lubricated	1. Adjust shift cables (Sec. 2 and/or 4). 2. Replace cable(s) and adjust (Sec. 2 and/or 4 and 7). 3. Adjust (Sec. 2) or replace switch. 4. Select and install proper length cable (Sec. 2). 5. Replace and adjust (Sec. 2 and/or 4 and 7). 6. Repair as needed (Sec. 7). 7. Properly install nuts (Sec. 2 and/or 4). 8. Clean and lubricate (Sec. 1-B).
Drive unit jumps out of gear	1. Shift cables improperly adjusted 2. Transmission linkage improperly adjusted	1. Adjust shift cables (Sec. 2 and/or 4) 2. Adjust linkage (Sec. 2)

Steering System Troubleshooting

If Power Package is equipped with Power Steering, first determine if problem is caused by the Power Steering System or Ride Guide portion of the steering system.

Proceed as follows:

1. Remove clevis pin which attaches steering cable to Power Steering unit piston rod end clevis. Remove clevis pin which secures piston rod end clevis to stern drive steering lever.
2. Turn steering wheel thru entire steering range. If steering difficulty is encountered problem is located in Ride Guide steering system.

   If steering wheel turns with ease, problem is located in Power Steering system.

Problem	Possible Cause	Remedy
Hard Steering - Ride Guide Steering System	1. Damaged steering cable	1. Replace (Sec. 2).
	2. Steering cable too short (sharp bends) or too long (loops and long bends)	2. Select and install proper length cable (Sec. 2).
	3. Steering cable corroded or not lubricated	3. Lubricate or replace cable.
	4. Ride Guide rack or rotary head not lubricated	4. Disassemble and lubricate.
Hard Steering (with engine running) - Power Steering System	1. Low Power Steering pump fluid level	1. Check fluid level (Sec. 6-A).
	2. Loose Power Steering pump drive belt	2. Adjust belt tension (Sec. 6-A).
	3. Air in system	3. Locate source of air in lines or fittings, correct and air-bleed system (Sec. 6-A).
	4. Fluid leak	4. Locate and correct source of leak. (Sec 6-A).
	5. If the above 4 steps do not solve problem, test Power Steering system	5. Test Power Steering system (Sec. 6-A).
Power Steering System External Fluid Leaks	1. Pump reservoir leaking at fill cap (too full)	1. Remove fluid to bring to proper level.
	2. Pump reservoir leaking at fill cap (air or water in fluid)	2. Locate source of air or water and correct. Air also may enter because of low reservoir fluid level or internal pump leak. Test pump (Sec. 6-A).
	3. Loose hose connections	3. Tighten hose connections.
	4. Damaged hose	4. Replace hose.
	5. Bad cylinder piston rod seal	5. Replace seal (Sec. 6-A).
	6. Damaged or worn control valve seals	6. Replace seals (Sec. 6-A).
	7. Bad Power Steering pump seals and "O" rings	7. Repair pump (Sec. 6-A).
	8. Cracked or porous metal parts	8. Replace.

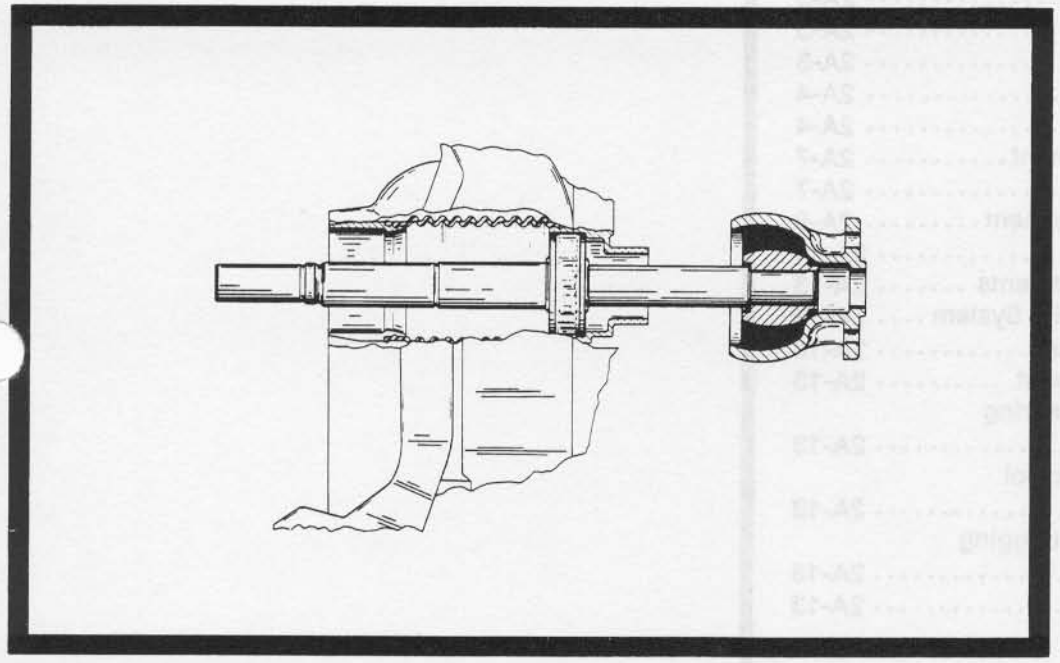
Power Trim System Troubleshooting

Refer to Section 5-A or 5-B

REMOVAL, INSTALLATION and ADJUSTMENTS

2

A



mercruiser
STERN DRIVES & INBOARDS

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Specifications

Torque Specifications

NOTE: Listed Below Are the Torque Specifications for Those Fasteners Which Have a Specific Torque Value. Tighten All Other Fasteners, Not Listed, Securely.

Description	Torque Value
Drive Shaft to Tailstock Housing Bolts	50 lbs. ft. (68 N.m)
Drive Shaft to Transmission Output Shaft Nuts	35 lbs. ft. (48 N.m)
Gimbal Housing Stud to Inner Transom Plate Nuts	25-30 lbs. ft. (34-41 N.m)
Power Steering Hydraulic Hose Fittings - Large	20-25 lbs. ft. (27-34 N.m)
- Small	96-108 lbs. in. (10.8-12.2 N.m)
Power Trim Cylinder to Anchor Pin, Nut	Tighten until approximately 2 threads show - Do Not overtighten
Propeller Nut	55 lbs. ft. (75 N.m)
Shift Cable Brass Barrel to Transmission Anchor Stud Nut	Tighten nut until it bottoms out against flat washer, then back-off 1/2 turn
Shift Cable End Guide to Shift Cable Lever Stud Nut	Tighten nut until it bottoms out against flat washer, then back-off 1/2 turn
Steering Cable Coupler Nut	35 lbs. ft. (48 N.m)
Steering Cable Guide Tube Attaching Nut/Sleeve	35 lbs. ft. (48 N.m)
Steering Link Rod to Cable End Adaptor Castle Nut	20-25 lbs. in. (2.3-2.8 N.m)
Steering Link Rod to Steering Lever Castle Nut	15-18 lbs. ft. (20-24 N.m)
Stern Drive Unit to Bell Housing Attaching Nuts	80 lbs. ft. (109 N.m)
Tailstock Housing "O" Ring Seal Compression Nuts	70 lbs. in. (7.9 N.m)
Tailstock Housing to Inner Transom Plate Support Bolts/ Nuts	100 lbs. ft. (136 N.m)

Lubricants, Sealers, and Adhesives

Description	Part No.
Quicksilver 2-4-C Marine-Lube	92-90018A12
Quicksilver Special Lubricant 101	92-79214A1
Quicksilver Liquid Neoprene	92-25711--1
Quicksilver Perfect Seal	92-34227--1

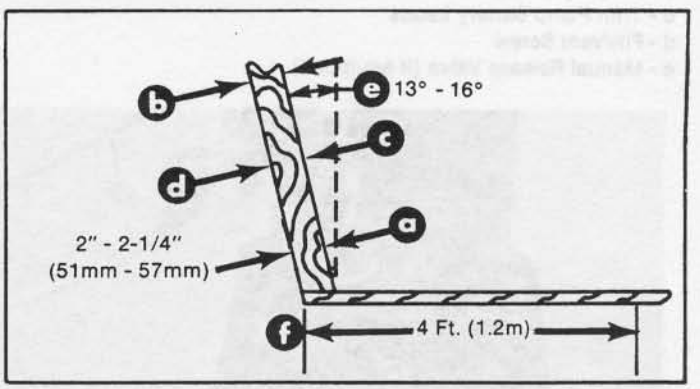
Special Installation Tools

Description	Part No.
Transom Drilling Fixture	91-55852A2
Engine Alignment Tool	91-57797A3

Special Information

Special Installation Information

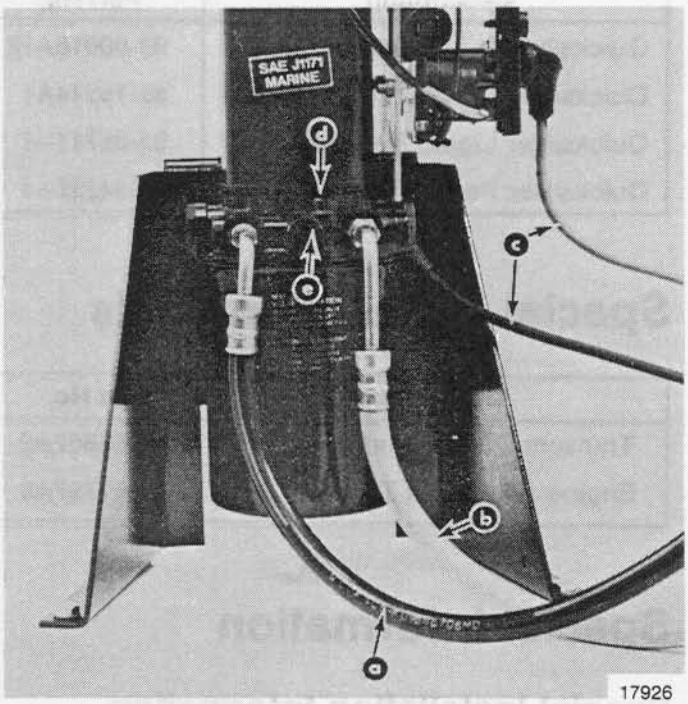
TRANSOM SPECIFICATIONS



a - Transom Thickness - To be 2 In. (51mm) Minimum to 2-1/4 In. (57mm) Maximum
b - Transom Surfaces - MUST BE Parallel Within 1/8 In. (3.2mm) Measured at Top and Bottom of Cutout Hole
c - Area Covered by Inner Transom Plate - MUST BE Flat Within 1/8 In. (3.2mm)
d - Area Covered by Gimbal Housing Assembly - MUST BE Flat Within 1/16 In. (1.6mm)
e - Transom Angle - 13° to 16°
f - Keel (if equipped) - Remove 4 Ft. (1.2mm) Forward of Transom

POWER TRIM PUMP INSTALLATION REQUIREMENTS

NOTE: Power package may be equipped with either an Oildyne or Prestolite Power Trim pump.



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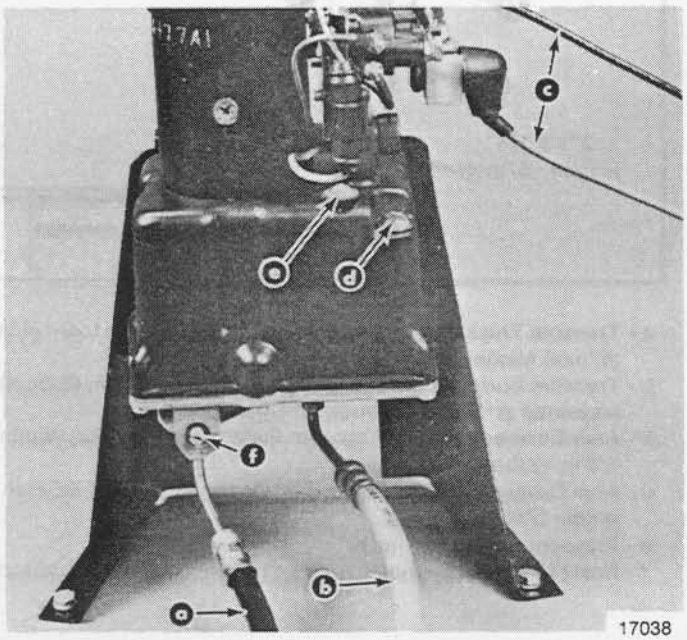
Oildyne Power Trim Pump

a - Black Hydraulic Hose
b - Gray Hydraulic Hose — from Housing Assembly
c - Trim Pump Battery Leads
d - Fill/Vent Screw
e - Manual Release Valve (if equipped)



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Typical Prestolite Power Trim Pump

a - Black Hydraulic Hose
b - Gray Hydraulic Hose
c - Trim Pump Battery Leads
d - Fill Screw
e - Vent Screw
f - Manual Release Valve (if equipped)

Pump location must meet the following requirements.

a. Mount within limits of hydraulic hoses.
b. Mount close to the battery so that trim pump battery leads can be connected.
c. Mount to allow easy access to the fill vent and Manual Release Valve, on pumps so equipped.
d. Mount in an area not exposed to water.
e. Trim pump must be mounted so that when steering wheel is turned in either direction (right or left) the power steering booster cylinder does not contact pump.

STEERING HELM and CABLE

Selection

Steering Systems are preset for cables with end dimensions which comply with the BIA Certification Handbook. Therefore, only cables that comply with BIA Certification Handbook end dimensions should be installed on this unit.

To ensure proper cable end dimension, we recommend the use of Ride Guide Steering cables.

⚠CAUTION
Power Steering Equipped Units Only

If cables with improper dimensions are installed, severe damage to transom assembly and/or steering system may result. Do not attempt to adjust cable guide tube, as guide tube and locknut have been torqued with Loctite (applied at the factory), and an attempt to loosen nut or tube may result in damage to tube.

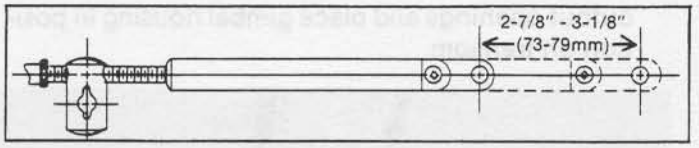
⚠CAUTION
Ride Guide Steering cables must be the correct length when installed.

REMOTE SHIFT CONTROL and CABLE

Selection

We recommend the use of a Quicksilver remote control and shift cable.

Remote control must provide the shift cable travel shown to properly shift the drive unit. Pull out on cable when checking dimension in forward gear and push in on end guide when checking dimension in reverse gear.

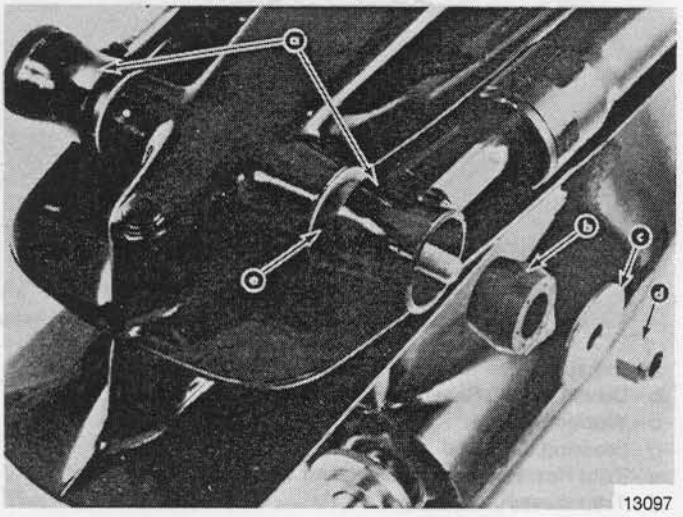


Remote Control Shift Cable Travel

Removal

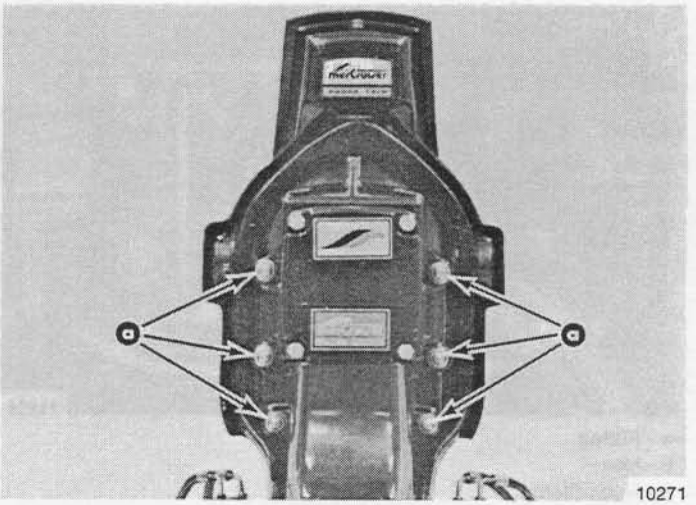
Stern Drive Unit

1. Shift remote control into forward gear.
2. Remove Power Trim cylinders (aft end) from drive shaft housing.



a - Trim Cylinder Aft Pivot Ends
b - Rubber Bushings (One Each Side)
c - Small ID Flat Washer (One Each Side)
d - Elastic Stop Nut (One Each Side)
e - Spiral Ground Spring

3. Remove drive unit attaching nuts, washers and drive unit.



a - Flat Washers and Elastic Stop Nuts

STEERING SYSTEM

Refer to Section 6.

ENGINE

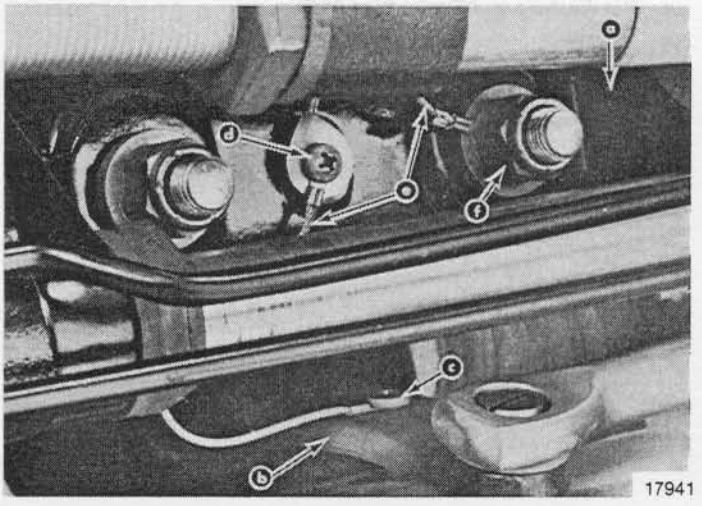
Refer to appropriate engine service manual.

POWER TRIM PUMP

Refer to Section 5.

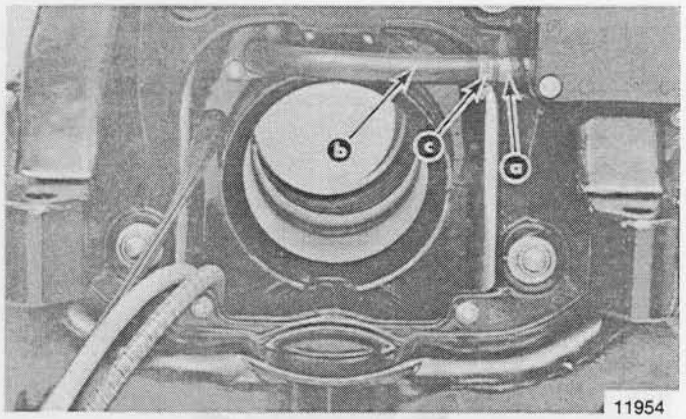
TRANSOM ASSEMBLY

1. Disconnect inner transom plate ground wires (if equipped).



a - Inner Transom Plate
b - Steering Lever
c - Slotted Screw
d - Ground Screw
e - Ground Wire
f - Locknut

2. Disconnect and plug hose from oil reservoir and cap fitting.



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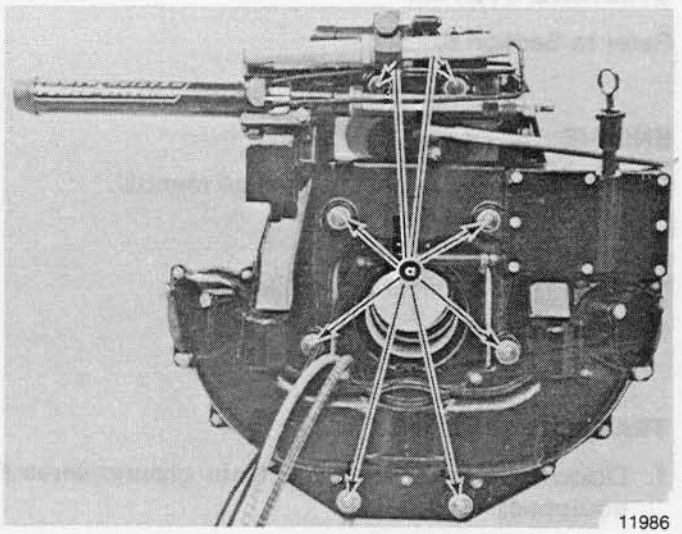
a - Fitting
b - Hose
c - Hose Clamp

3. Remove attaching nuts, flat washers and separate inner transom plate from gimbal housing.



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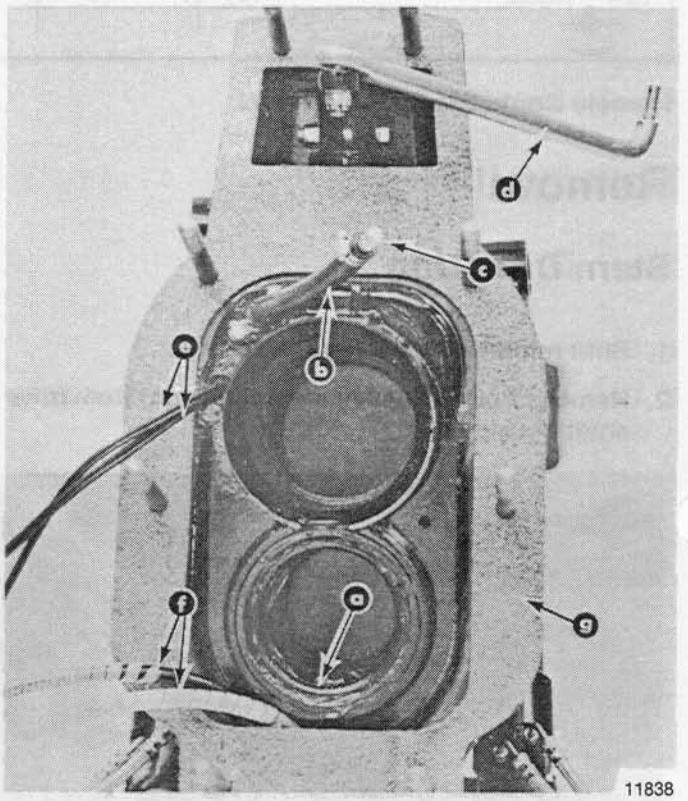
a - Flat Washers and Elastic Stop Nuts

Installation

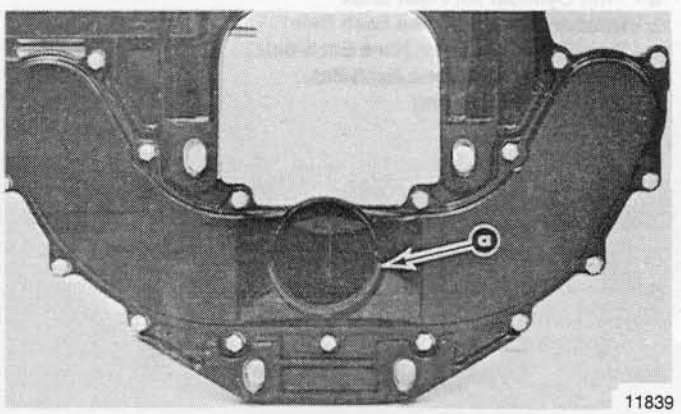
Transom Assembly

1. Lubricate exhaust tube "O" ring in gimbal housing and exhaust tube pilot on inner transom plate with 2-4-C Marine-Lube.
2. Check that cork gasket is properly positioned on gimbal housing studs then guide steering link rod, drive unit oil reservoir hose, trim limit switch and trim position sender leads and trim hoses thru cutout openings and place gimbal housing in position on transom.



11838

a - Exhaust Tube "O" Ring (Lubricate with 2-4-C Marine-Lube)
b - Drive Unit Oil Reservoir Hose
c - Wooden Dowel
d - Steering Link Rod
e - Trim Position Sender Leads and Trim Limit Switch Leads
f - Trim Hoses
g - Cork Gasket

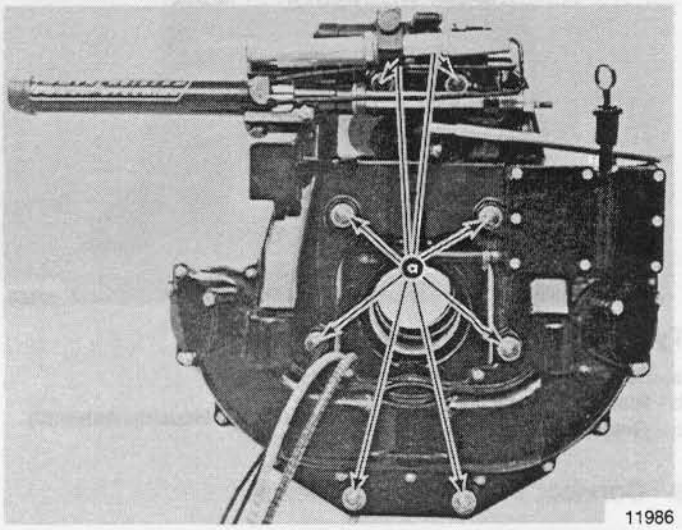


11839

a - Exhaust Tube Pilot (Lubricate with 2-4-C Marine-Lube)

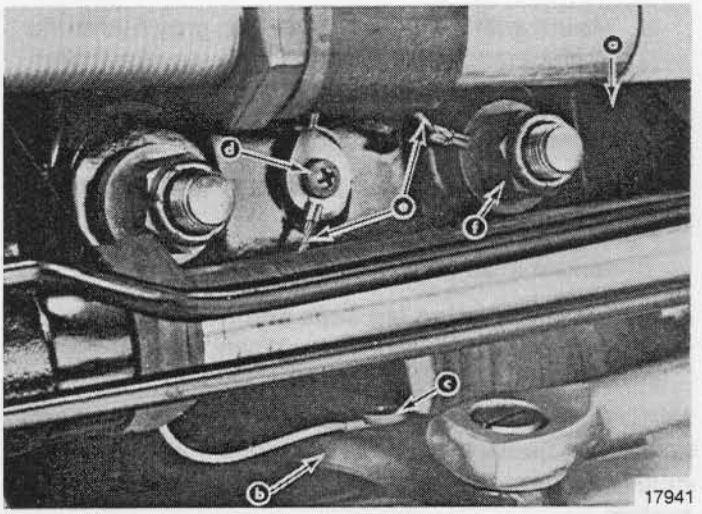
3. While holding gimbal housing in place, insert steering link rod, oil reservoir hose and trim leads and hoses thru openings in inner transom plate and install plate over gimbal housing studs.

4. Fasten gimbal housing and inner transom plate to transom with 8 flat washers and elastic stop nuts. Tighten nuts evenly (starting from center and working outward) until a torque of 25-30 lbs. ft. (34-41 N.m) is attained.



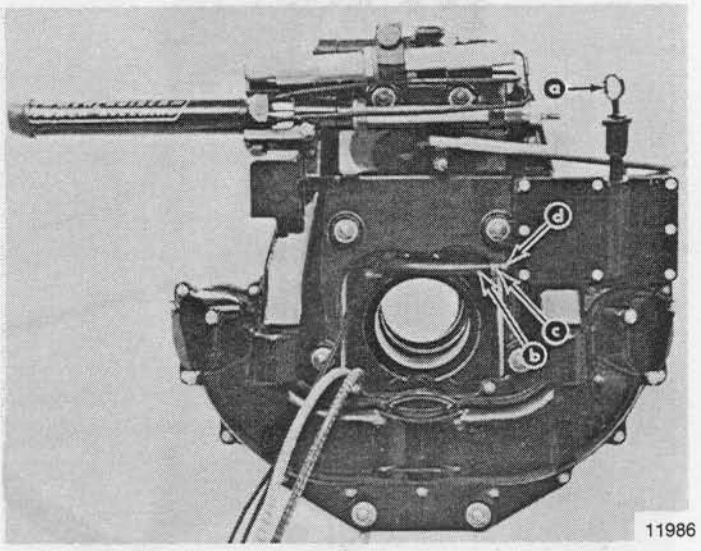
a - Flat Washers and Elastic Stop Nuts [Torque to 25-30 Lbs. Ft. (34-41 N.m)]

5. Connect inner transom plate ground wires. (if equipped)



a - Inner Transom Plate
b - Steering Lever
c - Slotted Screw
d - Ground Screw
e - Ground Wire
f - Locknut

6. Remove wooden dowel from drive unit oil reservoir hose and connect hose to oil reservoir barbed fitting. Be sure to tighten hose clamp securely.



a - Drive Unit Oil Reservoir Dipstick
b - Drive Unit Oil Reservoir Hose
c - Hose Clamp
d - Reservoir Barbed Fitting

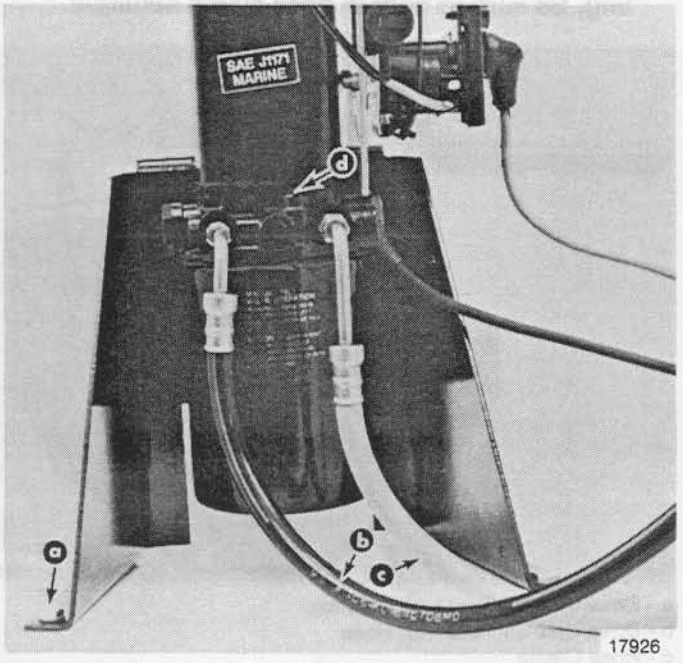
NOTE: If boat will not be equipped with the optional trim position indicator, wrap up the trim position sender leads and secure with a sta-strap. Trim position sender leads are those with ring terminal connectors on the ends. Do not wrap up trim limit switch leads which have bullet connectors on the ends.

7. Select an appropriate mounting location for the trim pump that meets the following requirements.
   a. Mount within limits of black and gray hydraulic hoses (coming from gimbal housing assembly).
   b. Mount close to the battery so that trim pump battery leads can be connected.
   c. Mount to allow easy access to the "Fill/Vent" screw.
   d. Mount in an area not be exposed to water.
8. Mount pump using lag bolts and flat washers and connect hydraulic hoses, as shown.

IMPORTANT: Power Trim system is filled with oil and air-bled at the factory. Make hydraulic connections as quickly as possible to prevent oil from leaking out of system.

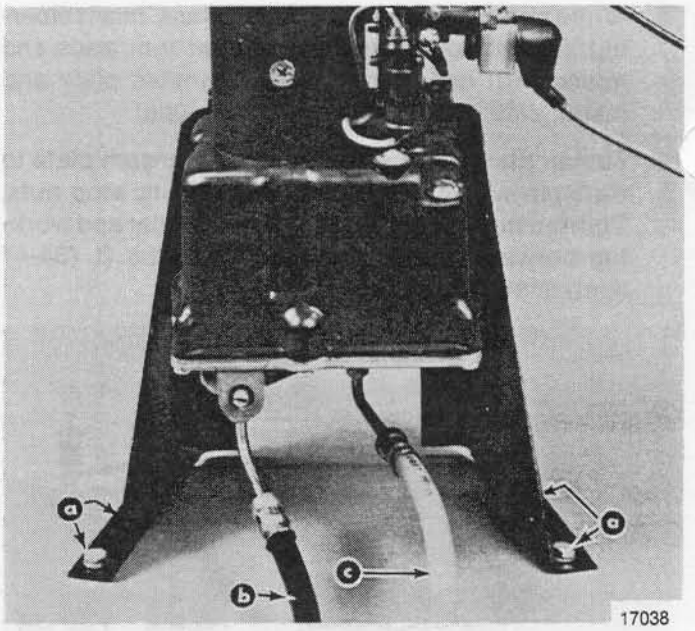
⚠CAUTION
Be careful not to cross-thread or over-tighten hose fittings.

"Fill/Vent" screw must be backed out 1 full turn (after bottoming out) to vent pump reservoir. Failure to back screw out could cause damage to pump.



Oildyne Pump

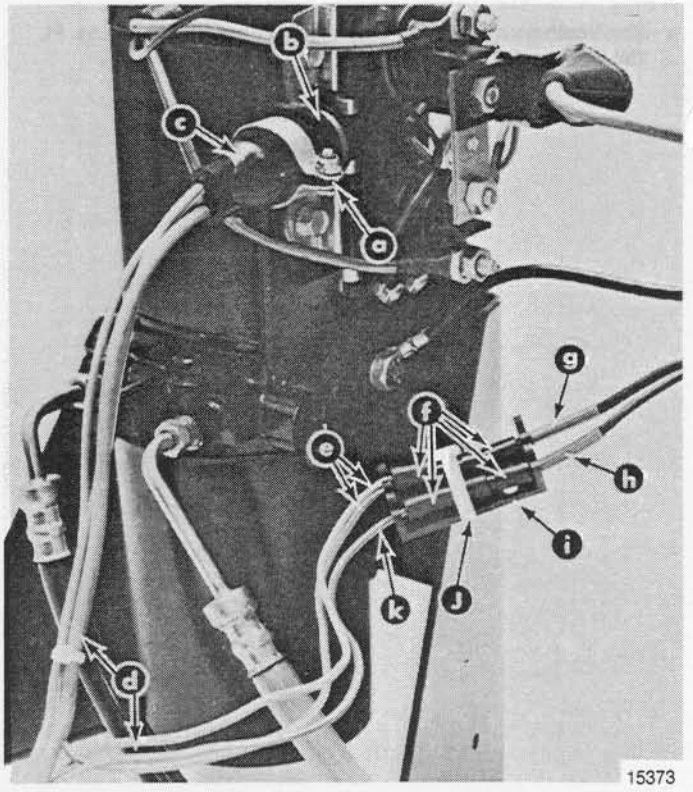
a - Lag Bolts and Flat Washers
b - Black Hydraulic Hose —┐
c - Gray Hydraulic Hose —┘— From Gimbal Housing Assembly
d - "Fill/Vent" Screw (MUST BE Backed Out 1 Full Turn)



Typical Prestolite Power Trim Pump

a - Secure Pump with Lag Bolts and Washers
b - Black Hydraulic Hose —┐
c - Gray Hydraulic Hose —┘— From Gimbal Housing Assembly

9. Connect trim limit switch leads.



a - Clamp, Screw and Locknut
b - Receptacle
c - Wiring Harness Connector
d - Trim Control Wiring Harness
e - Blue-White Wiring Harness Leads
f - Bullet Connectors
g - Trim Limit Switch Lead with Blue Sleeve
h - Trim Limit Switch Lead with Purple Sleeve
i - Connection Retainer
j - Sta-Strap
k - Purple-White Wiring Harness Lead

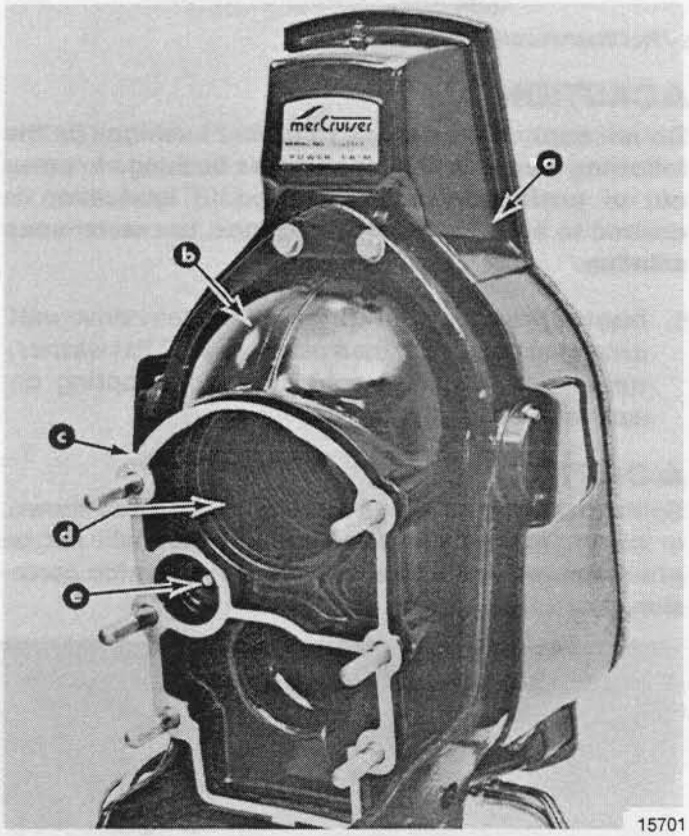
ENGINE INSTALLATION and ALIGNMENT

Refer to appropriate engine installation manual.

STERN DRIVE UNIT

IMPORTANT: DUAL INSTALLATIONS ONLY -- It is recommended that right-hand rotation drive unit (marked "RH" on end of propeller shaft) be installed on starboard (right) transom gimbal housing assembly and left-hand rotation drive unit (without any markings on end of propeller shaft) be installed on port (left) transom gimbal housing assembly. Drive units can be reversed; however, if desired on dual installations with side-by-side engines. On dual installations with staggered engine, drive units cannot be reversed, as units have different universal joint shafts. Installation procedure for both drive units is the same.

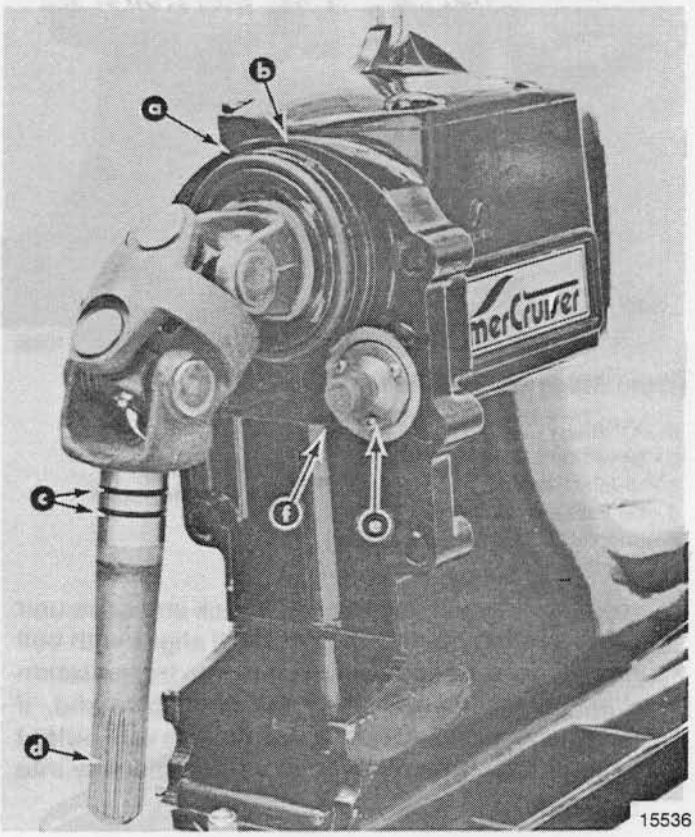
1. Place gasket in position on bell housing. Also, lubricate bell housing bore and oil passage connector with Quicksilver 2-4-C Marine-Lube.



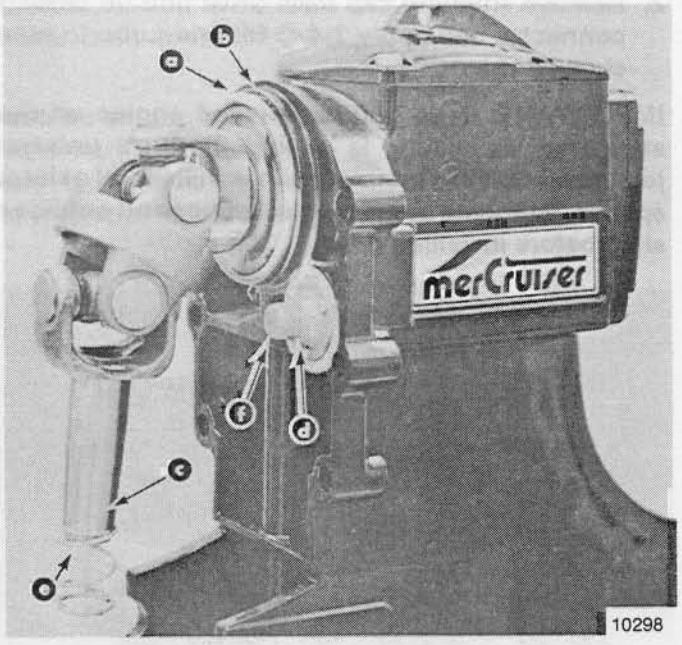
a - Gimbal Housing Assembly
b - Bell Housing
c - Gasket
d - Bell Housing Bore
e - Oil Passage Connector
— Lubricate with 2-4-C Marine—Lube

2. Remove shipping cap from drive unit oil passage connector and apply 2-4-C Marine-Lube to areas shown.

IMPORTANT: Drive unit for forward engine on dual staggered installation is equipped with a universal joint shaft that has internal splines instead of external splines. Lubricate both internal splines and outside of shaft before installing drive.



a - Pilot "O" Ring
b - Drive Shaft Housing Pilot
c - U-Joint Shaft "O" Rings
d - U-Joint Shaft Splines
e - Oil Passage Connector
f - Shipping Cap
— Lubricate with 2-4-C Marine Lube

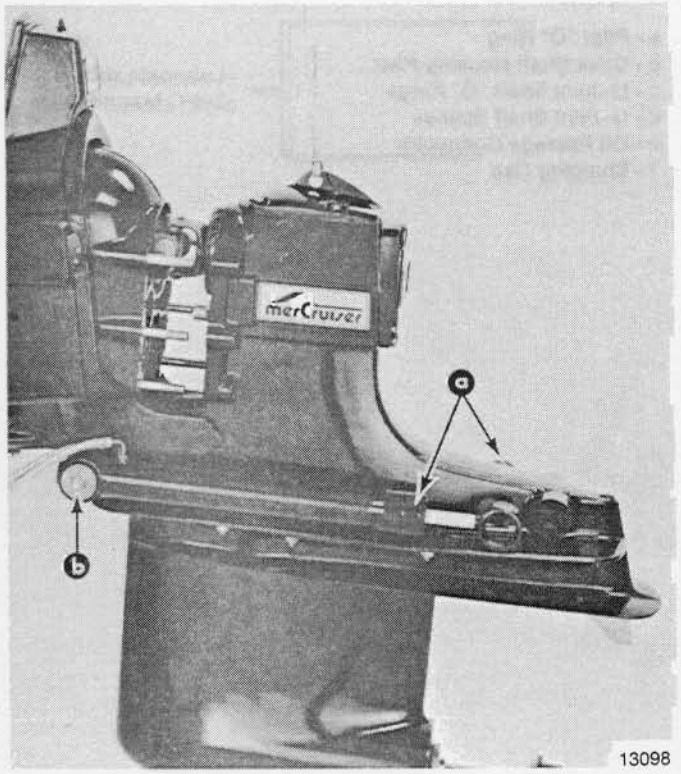


(Dual Staggard Installations)

a - "O" Ring
b - Drive Shaft Housing Pilot
c - U-Joint Shaft
d - Oil Passage Connector
e - Internal Splines
f - Shipping Cap

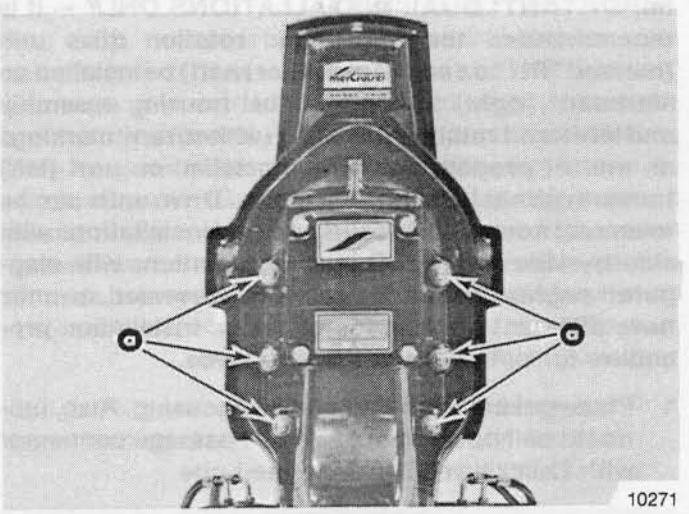
Lubricate with 2-4-C Marine Lube

3. Position trim cylinders straight back and drive unit (using a hoist) so that U-joint shaft aligns with bell housing bore. Guide U-joint shaft into transmission output shaft. Rotate propeller shaft by hand, if necessary, to align U-joint shaft splines with output shaft splines; then push drive unit all-the-way into bell housing.



a - Trim Cylinders b - Forward Anchor Pin

4. Lubricate threads on bell housing studs with 2-4-C Marine-Lube (to prevent threads from galling); then install 6 flat washers and elastic stop nuts (retained in Step 1) on studs. Torque nuts evenly (starting with center nuts and working out) to 80 lbs. ft. (109 N.m).



a - Flat Washers and Elastic Stop Nuts

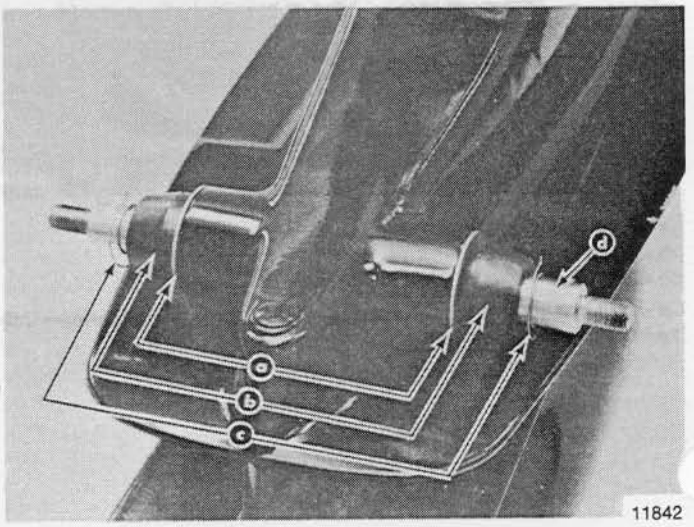
⚠CAUTION

Do not apply oil or grease to rubber bushings (in the following steps), as this may cause bushings to creep out of position during operation. If lubrication is desired to aid in installing bushings, use water soap solution.

5. Insert aft anchor pin thru hole in stern drive unit drive shaft housing; then place large ID flat washer, rubber bushing and spiral grounding spring on each end of pin, as shown.

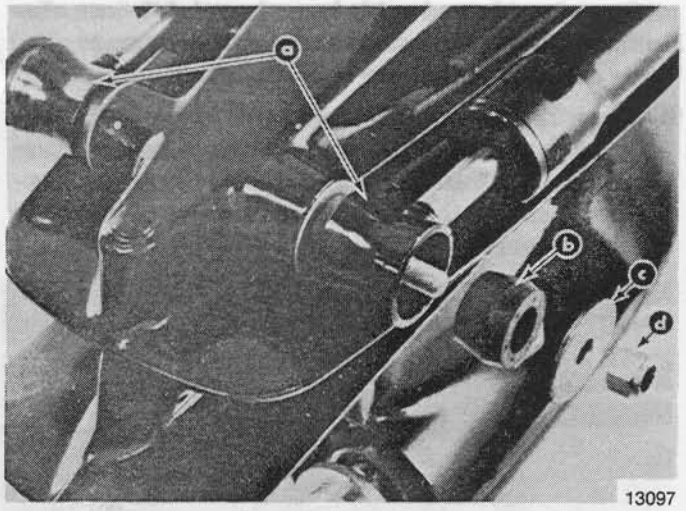
⚠CAUTION

Spiral grounding springs must be installed as shown, or piston rod and pivot end assemblies will not be grounded and could be damaged by galvanic corrosion.



a - Large ID Flat Washers
b - Rubber Bushings
c - Spiral Grounding Springs
d - Aft Anchor Pin

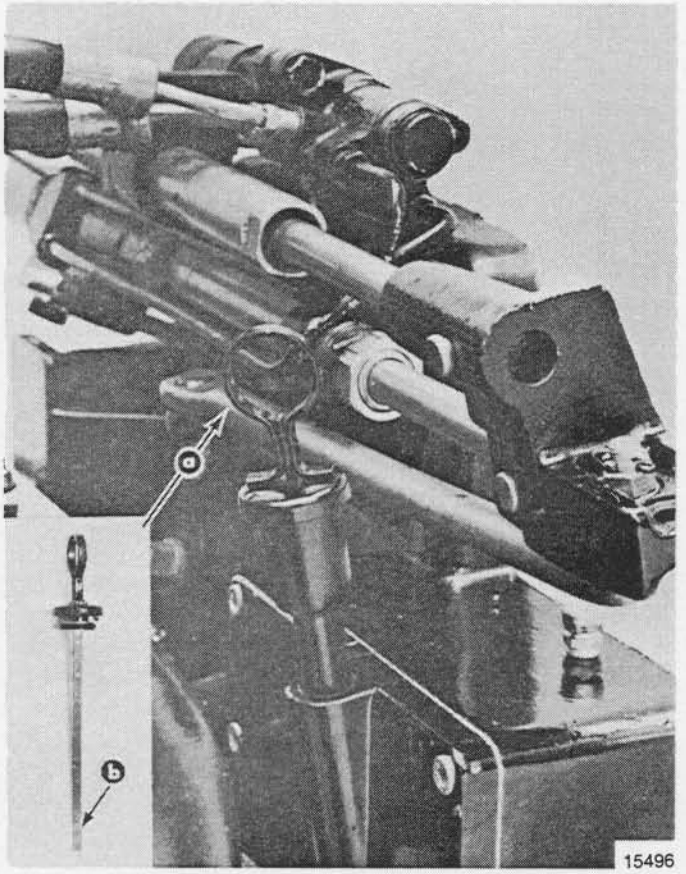
6. Lubricate anchor pin threads with 2-4-C Marine-Lube and assemble as shown.



a - Trim Cylinder Aft Pivot Ends
b - Rubber Bushings (One Each Side)
c - Small ID Flat Washer (One Each Side)
d - Elastic Stop Nut (One Each Side)

7. Tighten forward and aft anchor pin nuts until approximately 2 threads are exposed thru each nut. Do not over-tighten nuts, as rubber bushings may be damaged.

8. Remove dipstick from drive unit oil reservoir and fill reservoir with Super-Duty Lower Unit Lubricant (provided) until level reaches "F" (full) mark on dipstick. Recheck level after first use.

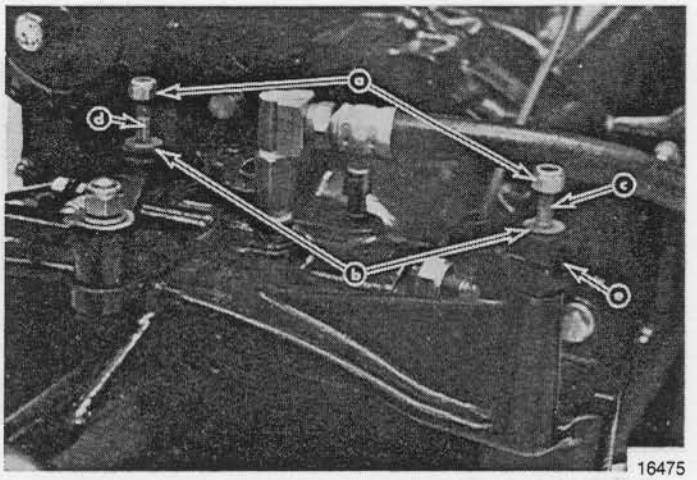


a - Dipstick b - "F" (Full) Mark

Shift Cable Installation and Adjustment

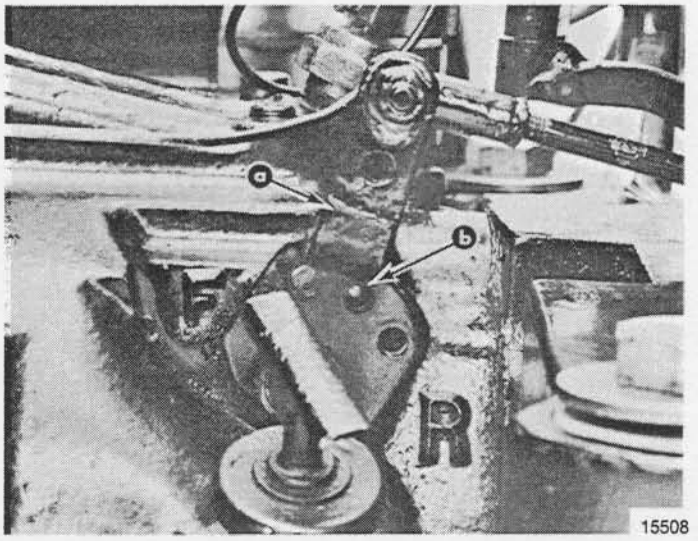
1. Place remote control lever (shift lever) in neutral position.

2. Remove elastic stop nuts, shift cable barrel clamp block and flat washers from transmission shift cable lever stud and shift cable anchor stud.



a - Elastic Stop Nuts
b - Flat Washers
c - Shift Cable Anchor Stud (Measure Shift Cable to this Point)
d - Shift Cable Lever Stud
e - Shift Cable Barrel Clamp Block

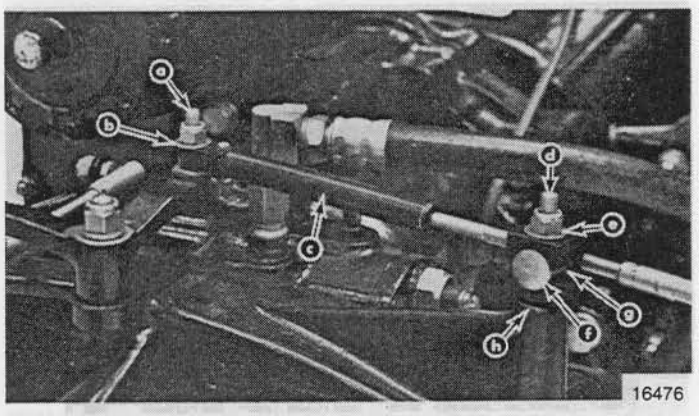
3. Place transmission shift lever in neutral position, indicated when poppet ball (located behind shift lever) is in center detent hole of shift lever.



a - Shift Lever
b - Poppet Ball in Center Hole of Shift Lever

4. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes (in cable end guide and brass barrel) with shift cable lever and shift cable anchor studs. Center the cable end play travel when making adjustment.

5. Install shift cable and secure with flat washers, shift cable barrel clamp block and elastic stop nuts (removed in Step 2). Tighten nuts until they bottom-out; then back off elastic stop nuts 1/2-turn after bottoming out.

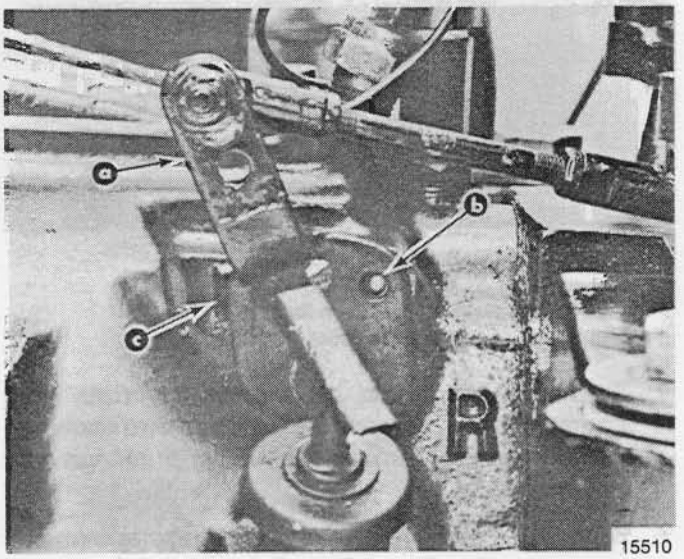


a - Shift Cable Lever Stud
b - Small Flat Washer and Elastic Stop Nut
c - Cable End Guide
d - Shift Cable Anchor Stud
e - Large Flat Washer and Elastic Stop Nut
f - Brass Barrel
g - Shift Cable Barrel Clamp Block
h - Flat Washer

⚠CAUTION

Be sure to back off elastic stop nuts, which secure cable end guide and cable brass barrel, 1/2-turn after bottoming it out. End guide and brass barrel must pivot freely on studs for proper shift operation.

6. Place remote control lever (shift lever) in full forward gear position. Check position of transmission shift lever. Transmission shift lever must be positioned so that the poppet ball is in rear detent hole of shift lever.

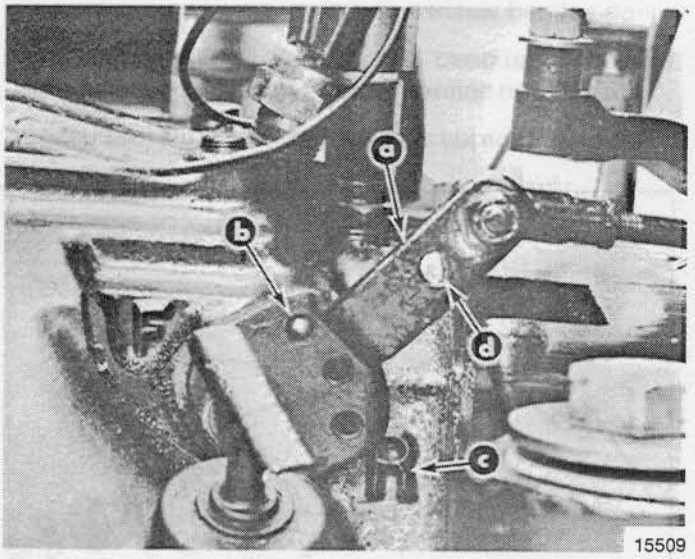


a - Shift Lever
b - Poppet Ball in Rear Detent Hole
c - "F" On Transmission Case

7. Place remote control lever in full reverse gear position and, again, check transmission shift lever position. Poppet ball must be in front detent hole of shift lever.
8. If transmission shift lever is positioned correctly in one gear (forward or reverse), but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift rod stud from top hole in transmission shift lever to bottom hole and recheck for proper positioning of shift lever. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

⚠CAUTION

Remote control and shift cable must position transmission shift lever so that it is fully in the forward and reverse gear detent positions and over the letter "F" on transmission case when propelling boat forward. Transmission shift lever must be positioned properly (without any modification to transmission) or transmission failure may occur. Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed; if the shift lever is repositioned or changed in any manner; or remote control and cable do not position shift lever correctly.



a - Shift Lever
b - Poppet Ball in Front Detent Hole
c - "R" On Transmission Case
d - Install Shift Rod Stud in This Hole, If Necessary, to Properly Position Shift Lever with Poppet Ball

Propeller Installation

⚠CAUTION

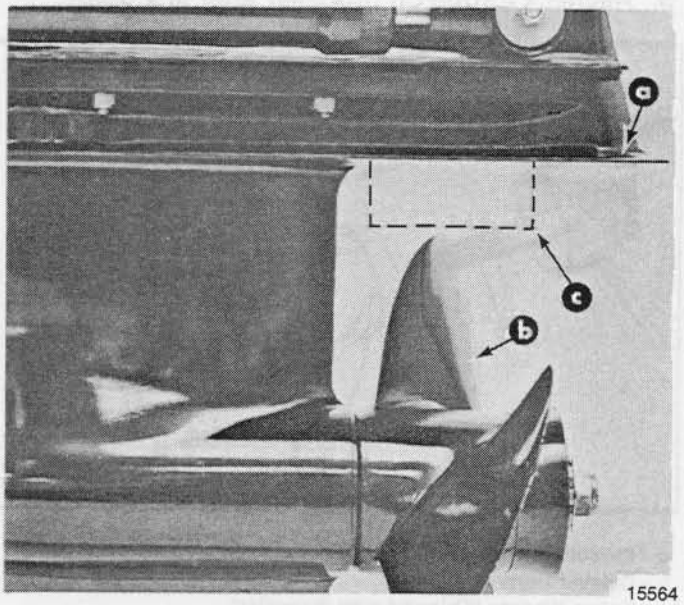
Be sure to use correct rotation propeller. Drive units with propeller shafts that are marked "RH" (on the end) must be equipped with right-hand rotation propellers. Drive units with unmarked propeller shafts must be equipped with left-hand rotation propellers. If incorrect rotation propeller is used, and transmission is run in reverse gear to propel boat forward, transmission failure will occur.

⚠WARNING

Before proceeding with propeller installation, make sure that remote control is in neutral position and ignition key is removed from switch.

⚠WARNING

When installing propeller nut, place a block of wood between the anti-ventilation plate and propeller to protect hands from propeller blades and to prevent propeller from turning.

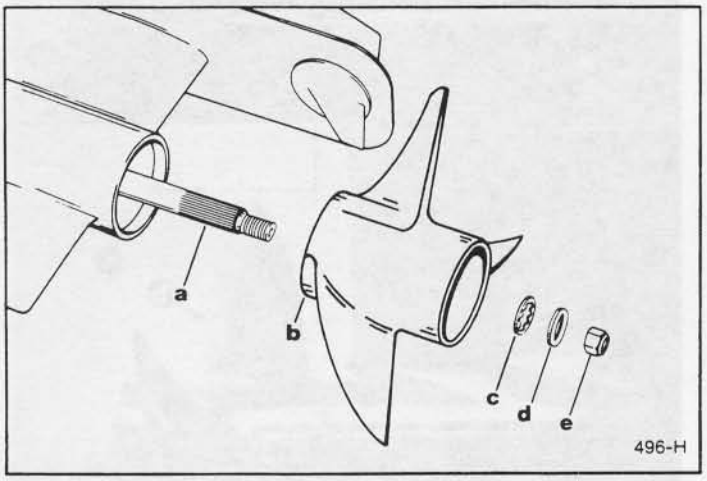


a - Anti-Ventilation Plate
b - Propeller
c - Place Block of Wood Here (Between "a" and "b")

TRS Cleaver Propellers with Solid Drive Hub

IMPORTANT: When using cleaver propellers with solid drive hub, the spline washer and flat washer packaged with propeller must be used in place of splined washer and tab washer shipped with drive unit. Propeller nut shipped with drive unit is used to secure propeller.

1. Apply a liberal coat of Special Lubricant 101, 2-4-C Marine-Lube or Perfect Seal to splines on propeller shaft, to aid in future removal of propeller. This is particularly necessary if boat is to be operated in salty, polluted or mineral-laden waters.
2. Align splines in propeller hub with splines on propeller shaft and slide propeller all-the-way onto shaft.
3. Place spline washer on shaft with concave (hollowed) side facing propeller and engage splines on washer with splines on shaft.
4. Install flat washer and propeller nut. Torque nut to 55 lbs. ft. (75 N.m) minimum.
5. Recheck torque on propeller after first usage.

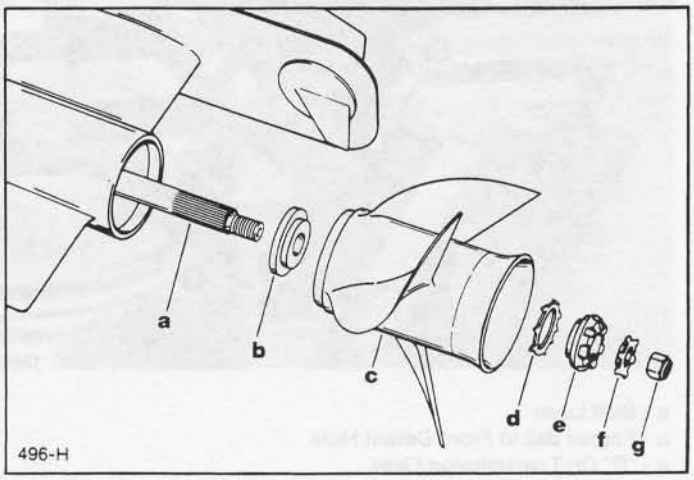


a - Propeller Shaft
b - Cleaver Propeller
c - Spline Washer (Shipped with Propeller)
d - Flat Washer (Shipped with Propeller)
e - Propeller Nut (Shipped with Drive Unit)

TRS Cleaver Propeller with Rubber Drive Hub

IMPORTANT: When using cleaver propellers with rubber drive hub, the front thrust hub packaged with propeller must be used. A splined washer, tab washer and propeller nut also are required and are shipped with drive unit.

1. Apply a liberal coat of Special Lubricant 101, 2-4-C Marine-Lube or Perfect Seal on splines of propeller shaft, to aid in future removal of propeller. This is particularly necessary if boat is to be operated in salty, polluted or mineral-laden waters.
2. Place front thrust hub into front end of propeller hub with stepped-side toward propeller.
3. Align splines in propeller with splines on propeller shaft and slide propeller and thrust hub assembly all-the-way onto shaft.
4. Place continuity and spline washers on propeller shaft and engage splines on washer with splines on shaft.
5. Place propeller nut into recess in tab washer, then thread nut and washer assembly onto propeller shaft. Tighten nut until a minimum torque of 55 lbs. ft. (75 N.m) is attained and continue to tighten until 3 of the tabs on tab washer align with grooves on splined washer.
6. Bend 3 aligned tabs on tab washer down into grooves on splined washer to secure propeller nut.
7. Recheck torque on propeller nut after first usage.



a - Apply Special Lubricant 101 on Splines of Propeller Shaft
b - Forward Thrust Hub
c - Propeller
d - Continuity Washer
e - Spline Washer
f - Tab Washer
g - Tighten Nut Until a MINIMUM Torque of 55 Lb. Ft. 75 N.m) Is Attained and Continue to Tighten Until 3 of the Tabs on Tab Washer Align with Grooves on Spline Washer. Bend 3 Tabs on Tab Washer Down in Grooves in Spline Washer

Quicksilver TR Propeller

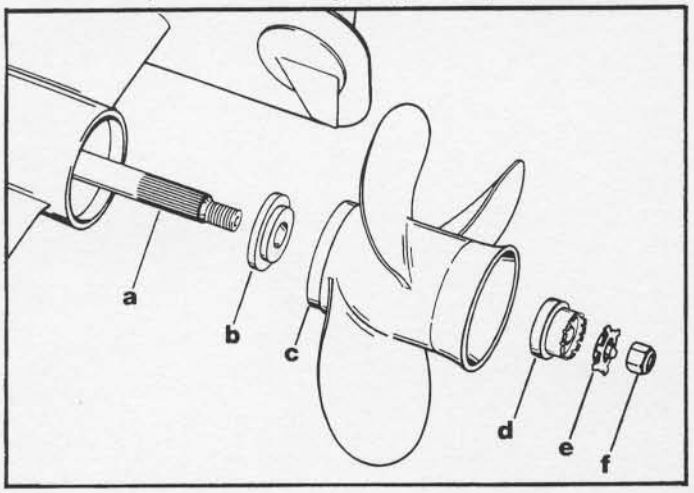
1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Quicksilver lubricants (listed in order of effectiveness):

   —Special Lubricant 101
   —2-4-C Marine-Lube
   —Perfect Seal

2. Place thrust hub-and-washer assembly into front end of propeller hub with shouldered (stepped) side toward propeller hub.
3. Align splines in propeller with splines on propeller shaft and slide propeller and thrust hub-and-washer assembly all-the-way onto shaft.
4. Place splined washer assembly on propeller shaft and engage splines in washer with splines on shaft.

IMPORTANT: If tab washer is to be reused, carefully inspect tabs for cracks or other damage. Tab washer prevents propeller nut from loosening during operation and should be replaced if condition is questionable.

5. Place propeller nut into recess in tab washer and thread nut and washer onto propeller shaft. Tighten nut until a minimum torque of 55 lbs. ft. (75 N.m) is attained; then, continue to tighten nut until 3 of the tabs on tab washer align with grooves on splined washer assembly.
6. Bend 3 aligned tabs on tab washer down into grooves in splined washer assembly to secure propeller nut.
7. Recheck propeller nut torque after first use and periodically thereafter. Be sure to rebend tabs on tab washer, down into grooves in splined washer assembly after checking torque on propeller nut.



a - Propeller Shaft
b - Thrust Hub and Washer Assembly
c - Propeller
d - Splined Washer Assembly
e - Tab Washer
f - Propeller Nut

In Service Preparation and Adjustments

FILLING and BLEEDING POWER TRIM SYSTEM

Refer to Section 5.

TRIM LIMIT SWITCH ADJUSTMENT

Refer to Section 4.

TRIM POSITION SENDER ADJUSTMENT

Refer to Section 4.

FILLING and BLEEDING POWER STEERING SYSTEM

Refer to Section 5.

BALANCING POWER STEERING CONTROL VALVE

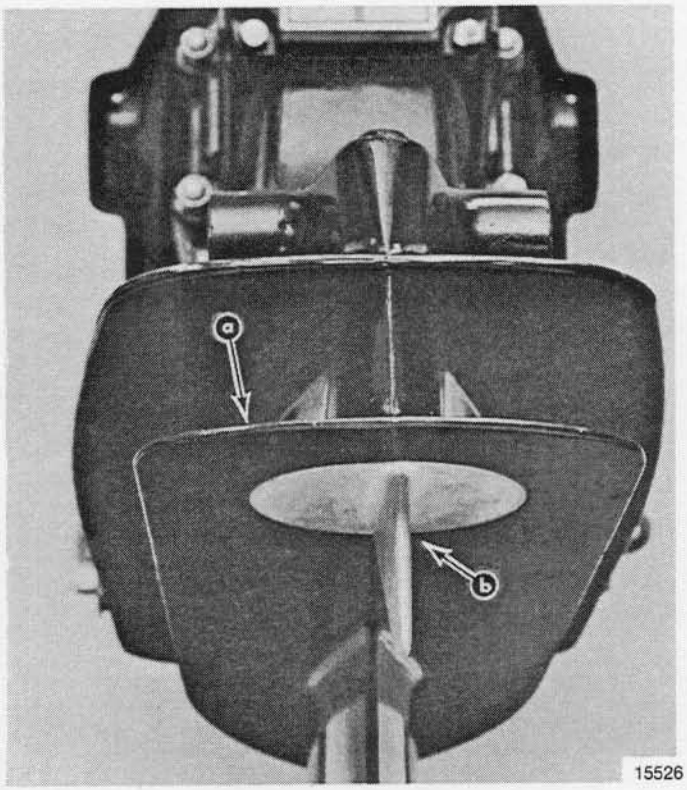
Refer to Section 6A.

CHECKING POWER STEERING FOR LUGGING CONDITION

Refer to Section 6A.

TRIM TAB ADJUSTMENT

Set zinc alloy tab (on bottom of anti-ventilation plate -- with the trailing edge straight back. See Section 1-B, "Trim Tab Replacement".



a - Anti-Ventilation Plate
b - Trim Tab

GENERAL INFORMATION

1

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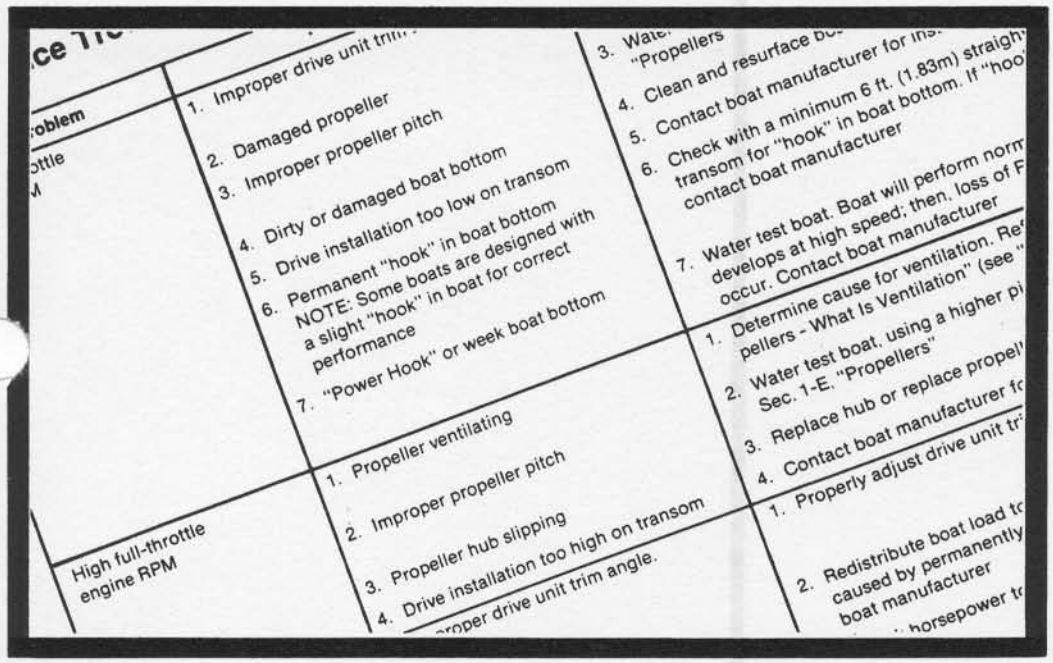

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ottle M	2. Damaged propeller	4. Clean and resurface bo...
	3. Improper propeller pitch	5. Contact boat manufacturer for ins...
	4. Dirty or damaged boat bottom	6. Check with a minimum 6 ft. (1.83m) straigh... transom for "hook" in boat bottom. If "hoo... contact boat manufacturer
	5. Drive installation too low on transom	
	6. Permanent "hook" in boat bottom NOTE: Some boats are designed with a slight "hook" in boat for correct performance	7. Water test boat. Boat will perform norm... develops at high speed; then, loss of P... occur. Contact boat manufacturer
	7. "Power Hook" or week boat bottom	1. Determine cause for ventilation. Ref... pellers - What Is Ventilation" (see "...
	1. Propeller ventilating	2. Water test boat, using a higher pi... Sec. 1-E, "Propellers"
	2. Improper propeller pitch	3. Replace hub or replace propell...
	3. Propeller hub slipping	4. Contact boat manufacturer fo...
High full-throttle engine RPM	4. Drive installation too high on transom	1. Properly adjust drive unit tri...
	...roper drive unit trim angle.	2. Redistribute boat load to... caused by permanently... boat manufacturer
		...horsepower to...

TROUBLESHOOTING

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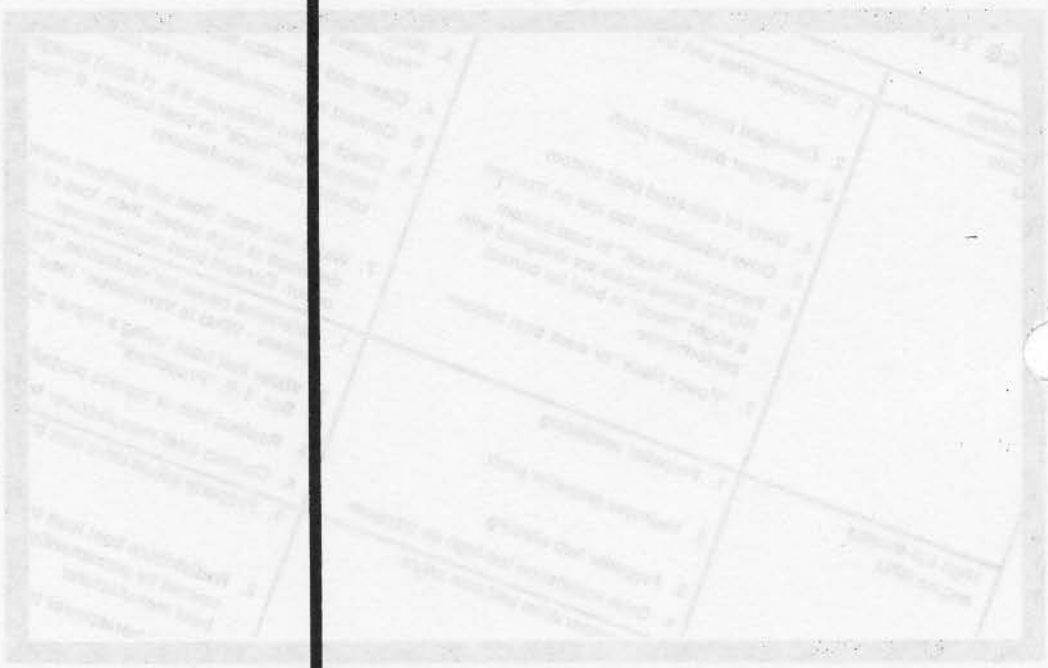


Troubleshooting

This section is a guide for performance and product troubleshooting. Referrals to specific sections of this manual are made where special tests or a repair procedure are to be performed.

Because of the relationship between Power Package components (engine and stern drive), it will be necessary, in some cases, to simultaneously refer to the appropriate MerCruiser Engine Service Manual for further troubleshooting information.

Much of this information will be familiar to the trained mechanic. Using this chart as a guide, allowing time for careful analysis, and a mechanics personal product experience will enable effective product troubleshooting.

Performance Troubleshooting

Problem	Possible Cause	Remedy
Low full-throttle engine RPM	1. Improper drive unit trim angle	1. Adjust drive unit trim angle.
	2. Damaged propeller	2. Repair or replace.
	3. Improper propeller pitch	3. Water test boat, using a lower pitch propeller. Refer to "Propellers" - Sec. 1-E.
	4. Dirty or damaged boat bottom	4. Clean and resurface boat bottom.
	5. Drive installation too low on transom	5. Contact boat manufacturer for installation specifications.
	6. Permanent "hook" in boat bottom NOTE: Some boats are designed with a slight "hook" for correct performance	6. Check with a minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If "hook" is found, contact boat manufacturer.
	7. "Power Hook" or weak boat bottom	7. Water test boat. Boat will perform normal until "hook" develops at high speed; then, loss of RPM and speed will occur. Contact boat manufacturer.
High full-throttle engine RPM	1. Propeller ventilating	1. Determine cause for ventilation. Refer to Sec. 1-E.
	2. Improper propeller pitch	2. Water test boat, using a higher pitch propeller. Refer to Sec. 1-E.
	3. Propeller hub slipping	3. Replace hub or propeller.
	4. Drive installation too high on transom	4. Contact boat manufacturer for installation specifications.
Poor boat performance and/or poor maneuverability - Bow too low	1. Improper drive unit trim angle	1. Adjust drive unit trim angle.
	2. Boat is bow heavy	2. Redistribute boat load to stern. If bow overweight is caused by permanently installed fuel tank(s), etc, contact boat manufacturer.
	3. Boat underpowered	3. Check horsepower to weight ratio, contact boat manufacturer.
	4. Permanent "hook" in boat bottom NOTE: Some boats are designed with a slight "hook" in boat for correct performance	4. Check with a minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If "hook" is found, contact boat manufacturer.
	5. "Power Hook" or weak boat bottom	5. Water test boat. Boat will perform normal until "hook" develops at high speed; then, loss of RPM and speed will occur.

Problem	Possible Cause	Remedy
Poor boat performance and/or poor maneuverability-Bow too high	1. Improper drive unit trim angle	1. Adjust drive unit trim angle.
	2. Boat is stern heavy	2. Redistribute boat load to bow. If stern overweight is caused by permanently installed fuel tank. etc., contact boat manufacturer.
	3. Improper propeller pitch - too high	3. Water test boat, using a lower pitch propeller. Refer to Sec. 1-E.
	4. Dirty boat bottom	4. Clean.
	5. "Rocker" in bottom of boat	5. Check with a minimum 6 Ft. (1.83m) straight edge from transom for "rocker" in boat bottom. If "rocker" is found, contact boat manufacturer.
	6. Propeller Ventilating/Cavitating	6. Refer to Sec. 1-E.

Stern Drive Unit Troubleshooting

Problem	Possible Cause	Remedy
Gear housing noise	1. Metal particles in drive unit lubricant	1. Dissassemble, clean and inspect, and replace necessary components. Refer to Sec. 3.
	2. Propeller incorrectly installed	2. Install propeller correctly. Refer to Sec. 1-E.
	3. Propeller shaft bent	3. Inspect and replace if necessary. Refer to Sec. 3.
	4. Incorrect gear shimming	4. Check gear housing back-lash and pinion gear height. Refer to Sec. 3-C.
	5. Worn or damaged gears and/or bearings caused by impact, overheating, or improper shimming	5. Disassemble inspect and replace. Refer to Sec. 3-C.
Drive shaft housing noise	1. Steering lever contacting transom cutout opening in turns.	1. Modify transom cutout.
	2. Propeller with untrue or out-of balance blades	2. Repair or replace, as required.
	3. Abnormal stern drive operation	3. Instruct operator on proper operating technique.
	4. U-Joint cross and bearing assembly C-Rings improperly installed or of incorrect size	4. Make sure that proper thickness C-Rings are used and that rings are fully seated in U-Joint bearing cap grooves (Sec. 3-B).
	5. Excessive side-to-side play in U-Joint cross and bearing assemblies	5. Install C-Ring Kit 53-12067A1 (Sec. 3-B).
	6. U-Joint bearing caps contacting center socket or drive shaft housing bearing retainer	6. Make sure that proper cross and bearing assemblies are being used. If interference is slight, grind off area on center socket or retainer where bearing caps are hitting. If interference is severe, replace center socket. (Sec. 3-B).
	7. U-Joint cross and bearings rough	7. Disassemble cross and bearing assemblies and inspect. DO NOT RELY ON FEEL. Replace assemblies if they show signs of scoring, galling, roughness, lack of lubricant, etc. (Sec. 3-B).
	8. O-Rings missing or flattened out on U-Joint shaft -- causing shaft to rattle against ID of gimbal bearing	8. Install new O-Rings (Sec. 3-B).
	9. Worn U-Joint shaft splines and/or engine coupler splines	9. Remove U-Joint coupling end yoke and insert into gimbal bearing and engine coupling. Rotate shaft back-and-forth. If play is excessive, replace U-Joint coupling end yoke and/or engine coupler, as necessary.

Problem	Possible Cause	Remedy
Drive shaft housing noise (continued)	10. Engine alignment incorrect	10. Adjust alignment, making sure that alignment tool moves in-and-out freely.
	11. Gimbal bearing rough	11. Replace gimbal bearing (Sec. 4). IMPORTANT: Gimbal bearing and carrier MUST BE replaced as an assembly as they are a matched set. Failure to do this may result in a loose bearing fit in carrier.
	12. Loose gimbal bearing	12. Reinstall bearing using a new tolerance ring, if carrier is loose in gimbal housing. If bearing is loose in carrier, bearing assembly must be replaced (Sec. 4).
	13. Gimbal bearing not fully seated in gimbal housing. Yoke moves back and forth in turns and may hammer against bearing if not fully seated	13. Drive bearing assembly into place. IMPORTANT: Gimbal bearing must be pressed in past lead-in chamfer in bearing bore (Sec. 4).
	14. Excessive clearance between gimbal ring and gimbal housing. This could cause misalignment between bell housing and gimbal housing and also may allow gimbal ring to vibrate up-and down in turns	14. Check and adjust clearance (Sec. 4).
	15. Stringer height uneven or transom assembly installed cocked on boat transom. This will affect engine alignment, but is usually not detectable with alignment tool	15. Measure distance between engine flywheel housing and inner transom plate on both sides. If distances are uneven, problem may be due to uneven stringer height or a a cocked transom assembly. Adjust stringer height or relocate transom cutout as required.
	16. Weak boat transom or boat bottom that flexes under power and causes engine misalignment	16. This condition can sometimes be detected by having someone force up-and-down on the drive unit while watching the inner transom plate. If movement can be observed, transom is weak and must be repaired.
	17. Rear engine mount attaching hardware improperly installed or missing	17. Reinstall hardware correctly.
	18. Improperly installed or failed rear engine mounts. This will affect engine alignment, but usually is not detectable with alignment tool	18. Check for uneven mount height or loose or soft mounts. Check to make sure that there is clearance between flywheel housing and fiber washer. If no clearance-exists, mounts have probably sagged. Install mounts correctly or replace as necessary.
	19. Engine mounting holes drilled off-center in inner transom plate engine supports	19. Check to make sure that holes are equally spaced and are equal distance from centerline.
	20. Boat transom too thin [1-3/4 in. (44mm) minimum]	20. Add thickness to transom.
	21. Boat transom thickness uneven [1/8 in. (3mm) variance maximum]. This could affect engine to transom assembly alignment and is usually not detectable with alignment tool	21. Repair boat as necessary.

Problem	Possible Cause	Remedy
Stern drive unit will not slide into bell housing	1. U-Joint shaft splines not aligned with transmission output housing splines 2. Engine not aligned 3. Gimbal bearing not properly installed 4. Damaged U-Joint shaft splines and/or transmission output housing splines.	1. Rotate propeller shaft COUNTERCLOCKWISE to align splines (Sec. 2). 2. Check engine alignment (Sec. 2). 3. Check engine alignment to determine if gimbal bearing may be cocked in gimbal housing (Sec. 2). 4. Inspect and replace if necessary.
Drive unit does not shift into gear; remote control shift handle moves	1. Shift cables improperly adjusted 2. Shift cables not connected 3. Inner core wire broken or loose 4. Transmission linkage improperly adjusted	1. Adjust shift cables (Sec. 2 and 4). 2. Install and adjust shift cables (Sec. 2 and/or 4). 3. Reconnect or replace inner core wire (Sec. 4). 4. Adjust linkage (Sec. 2)
Drive unit does not shift into gear; remote control shift handle does not move	1. Control box not properly assembled 2. Broken or damaged linkage in control box 3. Transmission linkage improperly adjusted 4. Controls improperly adjusted - Cable end guide hitting brass barrel	1. Properly reassemble (Sec. 7). 2. Repair (Sec. 7) 3. Adjust linkage (Sec. 2) 4. Adjust shift cables (Sec. 2 and/or 4).
Drive unit shifts hard	1. Shift cables improperly adjusted 2. Damaged remote control or drive unit shift cable 3. Shift cutout switch improperly adjusted or inoperative 4. Shift cable too short (sharp bends) or too long (loops and long bends) 5. Corroded shift cables 6. Internal wear in remote control box 7. Shift cable attaching nut too tight (end cannot pivot) 8. Shift cable pivot ends corroded or not lubricated	1. Adjust shift cables (Sec. 2 and/or 4). 2. Replace cable(s) and adjust (Sec. 2 and/or 4 and 7). 3. Adjust (Sec. 2) or replace switch. 4. Select and install proper length cable (Sec. 2). 5. Replace and adjust (Sec. 2 and/or 4 and 7). 6. Repair as needed (Sec. 7). 7. Properly install nuts (Sec. 2 and/or 4). 8. Clean and lubricate (Sec. 1-B).
Drive unit jumps out of gear	1. Shift cables improperly adjusted 2. Transmission linkage improperly adjusted	1. Adjust shift cables (Sec. 2 and/or 4) 2. Adjust linkage (Sec. 2)

Steering System Troubleshooting

If Power Package is equipped with Power Steering, first determine if problem is caused by the Power Steering System or Ride Guide portion of the steering system.

Proceed as follows:

1. Remove clevis pin which attaches steering cable to Power Steering unit piston rod end clevis. Remove clevis pin which secures piston rod end clevis to stern drive steering lever.
2. Turn steering wheel thru entire steering range. If steering difficulty is encountered problem is located in Ride Guide steering system.

   If steering wheel turns with ease, problem is located in Power Steering system.

Problem	Possible Cause	Remedy
Hard Steering - Ride Guide Steering System	1. Damaged steering cable	1. Replace (Sec. 2).
	2. Steering cable too short (sharp bends) or too long (loops and long bends)	2. Select and install proper length cable (Sec. 2).
	3. Steering cable corroded or not lubricated	3. Lubricate or replace cable.
	4. Ride Guide rack or rotary head not lubricated	4. Disassemble and lubricate.
Hard Steering (with engine running) - Power Steering System	1. Low Power Steering pump fluid level	1. Check fluid level (Sec. 6-A).
	2. Loose Power Steering pump drive belt	2. Adjust belt tension (Sec. 6-A).
	3. Air in system	3. Locate source of air in lines or fittings, correct and air-bleed system (Sec. 6-A).
	4. Fluid leak	4. Locate and correct source of leak. (Sec 6-A).
	5. If the above 4 steps do not solve problem, test Power Steering system	5. Test Power Steering system (Sec. 6-A).
Power Steering System External Fluid Leaks	1. Pump reservoir leaking at fill cap (too full)	1. Remove fluid to bring to proper level.
	2. Pump reservoir leaking at fill cap (air or water in fluid)	2. Locate source of air or water and correct. Air also may enter because of low reservoir fluid level or internal pump leak. Test pump (Sec. 6-A).
	3. Loose hose connections	3. Tighten hose connections.
	4. Damaged hose	4. Replace hose.
	5. Bad cylinder piston rod seal	5. Replace seal (Sec. 6-A).
	6. Damaged or worn control valve seals	6. Replace seals (Sec. 6-A).
	7. Bad Power Steering pump seals and "O" rings	7. Repair pump (Sec. 6-A).
	8. Cracked or porous metal parts	8. Replace.

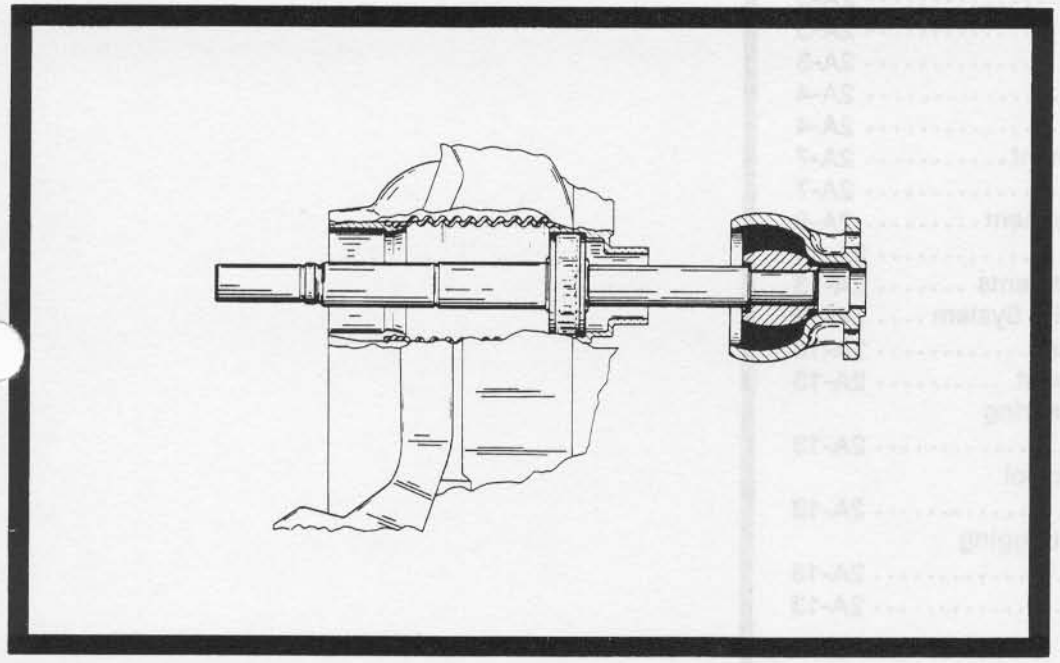
Power Trim System Troubleshooting

Refer to Section 5-A or 5-B

REMOVAL, INSTALLATION and ADJUSTMENTS

2

A



mercruiser
STERN DRIVES & INBOARDS

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Specifications

Torque Specifications

NOTE: Listed Below Are the Torque Specifications for Those Fasteners Which Have a Specific Torque Value. Tighten All Other Fasteners, Not Listed, Securely.

Description	Torque Value
Drive Shaft to Tailstock Housing Bolts	50 lbs. ft. (68 N.m)
Drive Shaft to Transmission Output Shaft Nuts	35 lbs. ft. (48 N.m)
Gimbal Housing Stud to Inner Transom Plate Nuts	25-30 lbs. ft. (34-41 N.m)
Power Steering Hydraulic Hose Fittings - Large	20-25 lbs. ft. (27-34 N.m)
- Small	96-108 lbs. in. (10.8-12.2 N.m)
Power Trim Cylinder to Anchor Pin, Nut	Tighten until approximately 2 threads show - Do Not overtighten
Propeller Nut	55 lbs. ft. (75 N.m)
Shift Cable Brass Barrel to Transmission Anchor Stud Nut	Tighten nut until it bottoms out against flat washer, then back-off 1/2 turn
Shift Cable End Guide to Shift Cable Lever Stud Nut	Tighten nut until it bottoms out against flat washer, then back-off 1/2 turn
Steering Cable Coupler Nut	35 lbs. ft. (48 N.m)
Steering Cable Guide Tube Attaching Nut/Sleeve	35 lbs. ft. (48 N.m)
Steering Link Rod to Cable End Adaptor Castle Nut	20-25 lbs. in. (2.3-2.8 N.m)
Steering Link Rod to Steering Lever Castle Nut	15-18 lbs. ft. (20-24 N.m)
Stern Drive Unit to Bell Housing Attaching Nuts	80 lbs. ft. (109 N.m)
Tailstock Housing "O" Ring Seal Compression Nuts	70 lbs. in. (7.9 N.m)
Tailstock Housing to Inner Transom Plate Support Bolts/ Nuts	100 lbs. ft. (136 N.m)

Lubricants, Sealers, and Adhesives

Description	Part No.
Quicksilver 2-4-C Marine-Lube	92-90018A12
Quicksilver Special Lubricant 101	92-79214A1
Quicksilver Liquid Neoprene	92-25711--1
Quicksilver Perfect Seal	92-34227--1

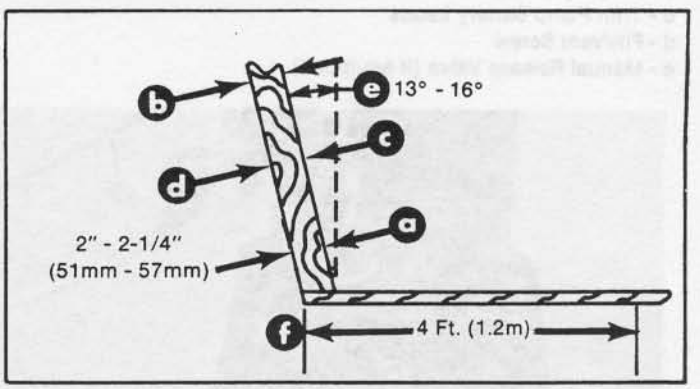
Special Installation Tools

Description	Part No.
Transom Drilling Fixture	91-55852A2
Engine Alignment Tool	91-57797A3

Special Information

Special Installation Information

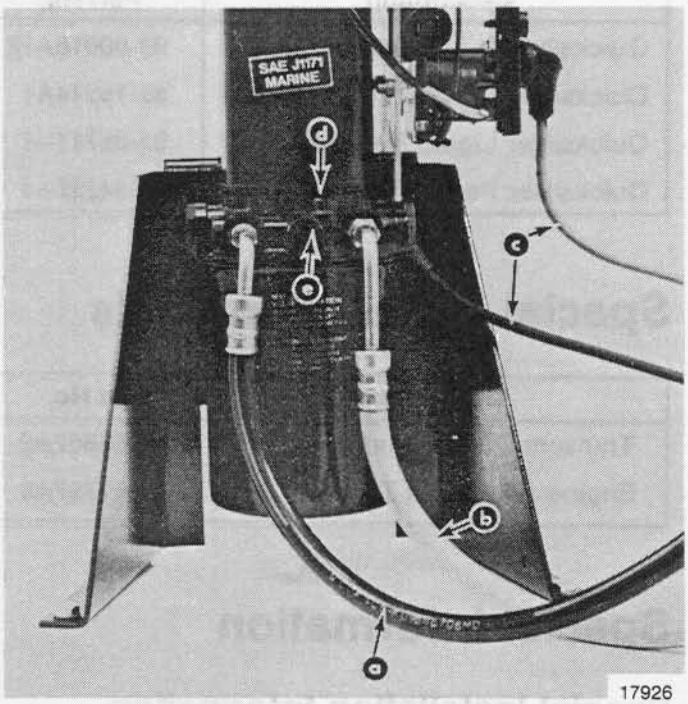
TRANSOM SPECIFICATIONS



a - Transom Thickness - To be 2 In. (51mm) Minimum to 2-1/4 In. (57mm) Maximum
b - Transom Surfaces - MUST BE Parallel Within 1/8 In. (3.2mm) Measured at Top and Bottom of Cutout Hole
c - Area Covered by Inner Transom Plate - MUST BE Flat Within 1/8 In. (3.2mm)
d - Area Covered by Gimbal Housing Assembly - MUST BE Flat Within 1/16 In. (1.6mm)
e - Transom Angle - 13° to 16°
f - Keel (if equipped) - Remove 4 Ft. (1.2mm) Forward of Transom

POWER TRIM PUMP INSTALLATION REQUIREMENTS

NOTE: Power package may be equipped with either an Oildyne or Prestolite Power Trim pump.



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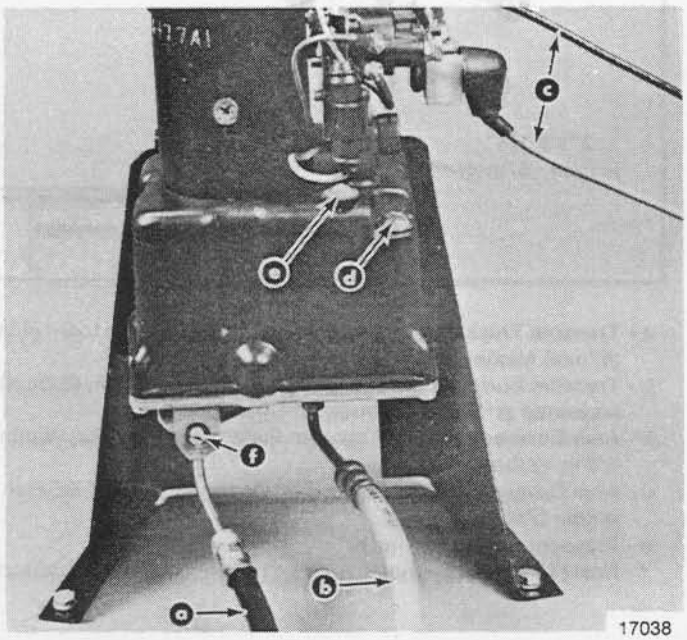
Oildyne Power Trim Pump

a - Black Hydraulic Hose
b - Gray Hydraulic Hose — from Housing Assembly
c - Trim Pump Battery Leads
d - Fill/Vent Screw
e - Manual Release Valve (if equipped)



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Typical Prestolite Power Trim Pump

a - Black Hydraulic Hose
b - Gray Hydraulic Hose
c - Trim Pump Battery Leads
d - Fill Screw
e - Vent Screw
f - Manual Release Valve (if equipped)

Pump location must meet the following requirements.

a. Mount within limits of hydraulic hoses.
b. Mount close to the battery so that trim pump battery leads can be connected.
c. Mount to allow easy access to the fill vent and Manual Release Valve, on pumps so equipped.
d. Mount in an area not exposed to water.
e. Trim pump must be mounted so that when steering wheel is turned in either direction (right or left) the power steering booster cylinder does not contact pump.

STEERING HELM and CABLE

Selection

Steering Systems are preset for cables with end dimensions which comply with the BIA Certification Handbook. Therefore, only cables that comply with BIA Certification Handbook end dimensions should be installed on this unit.

To ensure proper cable end dimension, we recommend the use of Ride Guide Steering cables.

⚠CAUTION
Power Steering Equipped Units Only

If cables with improper dimensions are installed, severe damage to transom assembly and/or steering system may result. Do not attempt to adjust cable guide tube, as guide tube and locknut have been torqued with Loctite (applied at the factory), and an attempt to loosen nut or tube may result in damage to tube.

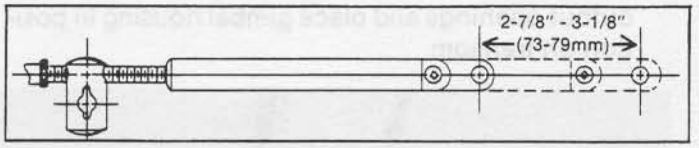
⚠CAUTION
Ride Guide Steering cables must be the correct length when installed.

REMOTE SHIFT CONTROL and CABLE

Selection

We recommend the use of a Quicksilver remote control and shift cable.

Remote control must provide the shift cable travel shown to properly shift the drive unit. Pull out on cable when checking dimension in forward gear and push in on end guide when checking dimension in reverse gear.

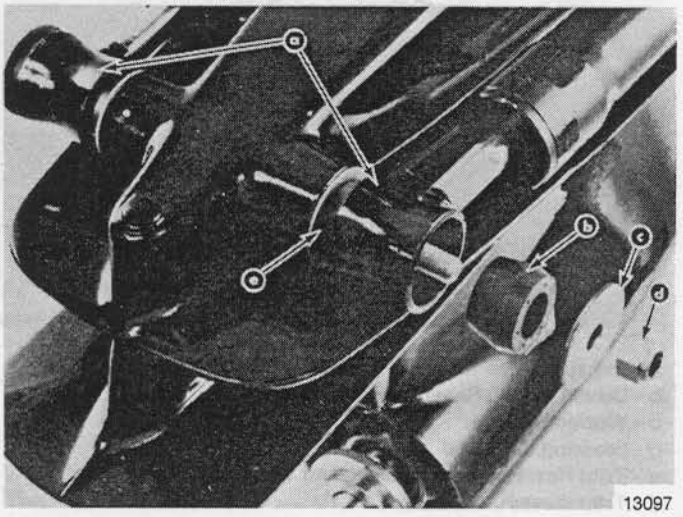


Remote Control Shift Cable Travel

Removal

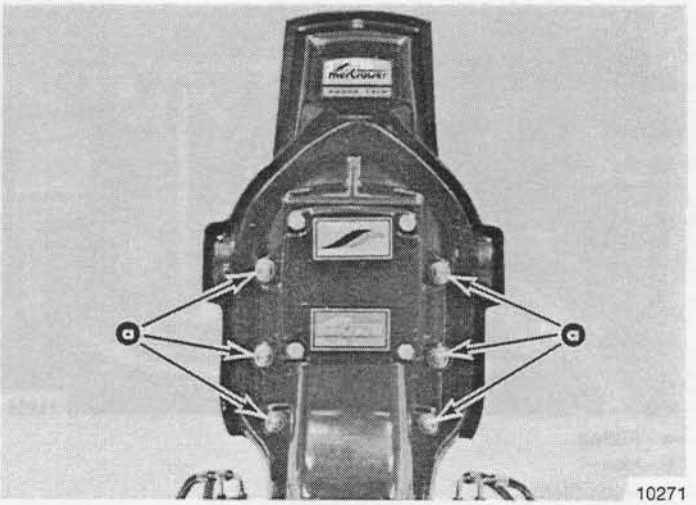
Stern Drive Unit

1. Shift remote control into forward gear.
2. Remove Power Trim cylinders (aft end) from drive shaft housing.



a - Trim Cylinder Aft Pivot Ends
b - Rubber Bushings (One Each Side)
c - Small ID Flat Washer (One Each Side)
d - Elastic Stop Nut (One Each Side)
e - Spiral Ground Spring

3. Remove drive unit attaching nuts, washers and drive unit.



a - Flat Washers and Elastic Stop Nuts

STEERING SYSTEM

Refer to Section 6.

ENGINE

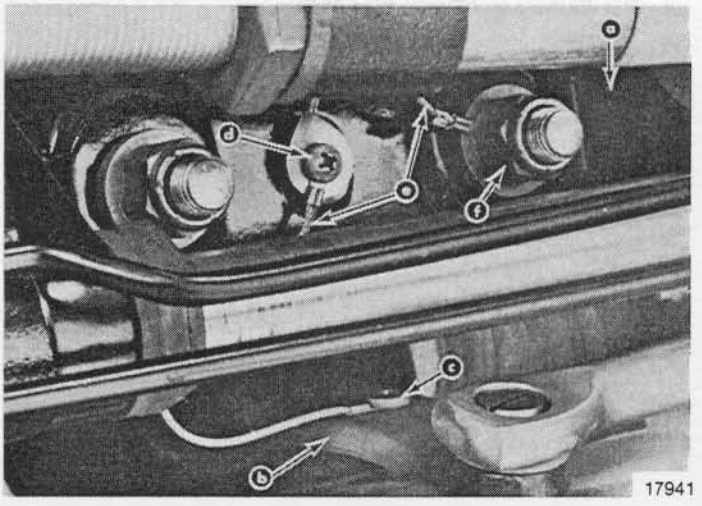
Refer to appropriate engine service manual.

POWER TRIM PUMP

Refer to Section 5.

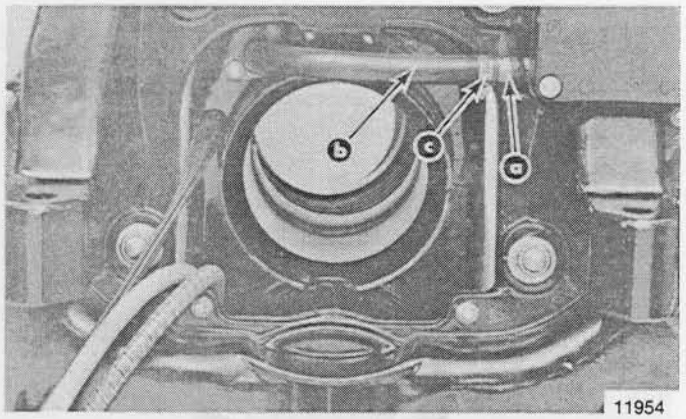
TRANSOM ASSEMBLY

1. Disconnect inner transom plate ground wires (if equipped).



a - Inner Transom Plate
b - Steering Lever
c - Slotted Screw
d - Ground Screw
e - Ground Wire
f - Locknut

2. Disconnect and plug hose from oil reservoir and cap fitting.



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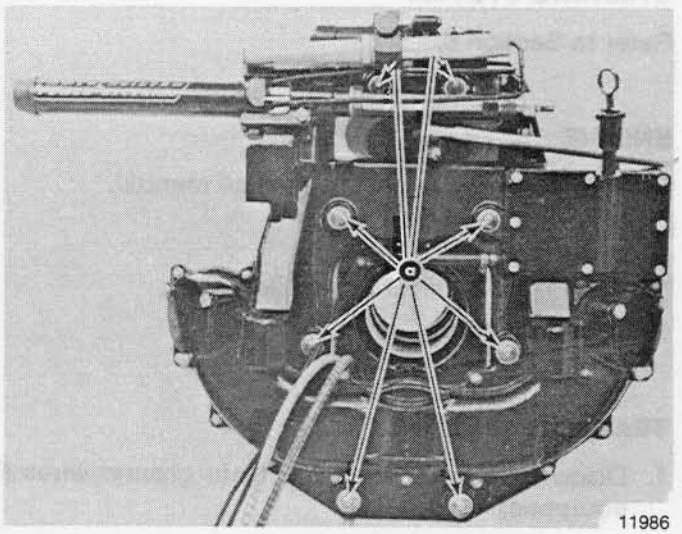
a - Fitting
b - Hose
c - Hose Clamp

3. Remove attaching nuts, flat washers and separate inner transom plate from gimbal housing.



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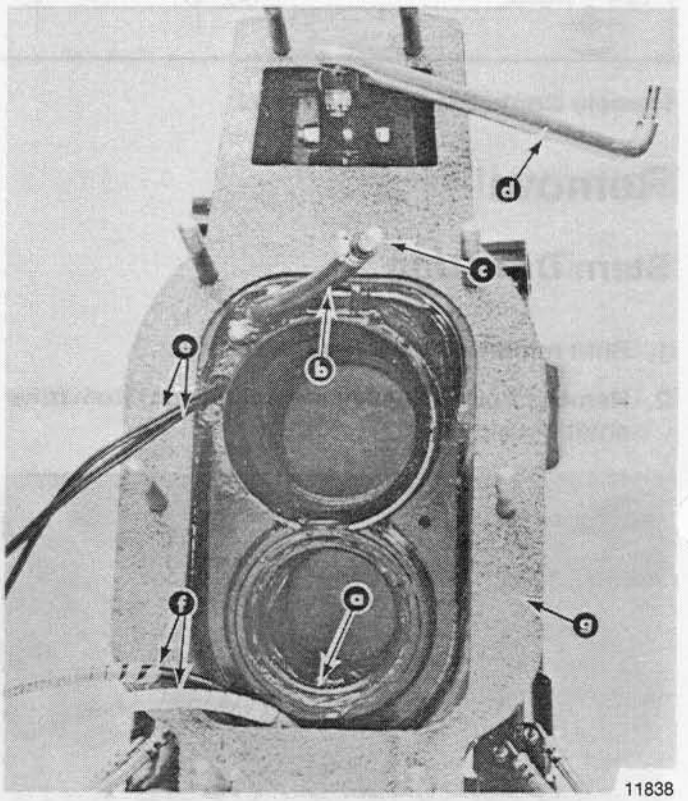
a - Flat Washers and Elastic Stop Nuts

Installation

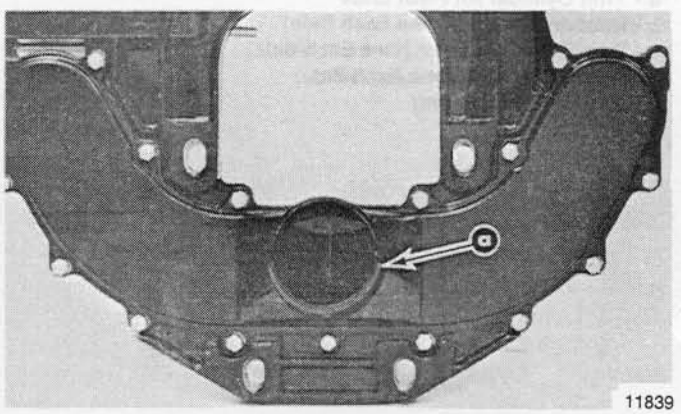
Transom Assembly

1. Lubricate exhaust tube "O" ring in gimbal housing and exhaust tube pilot on inner transom plate with 2-4-C Marine-Lube.
2. Check that cork gasket is properly positioned on gimbal housing studs then guide steering link rod, drive unit oil reservoir hose, trim limit switch and trim position sender leads and trim hoses thru cutout openings and place gimbal housing in position on transom.



11838

a - Exhaust Tube "O" Ring (Lubricate with 2-4-C Marine-Lube)
b - Drive Unit Oil Reservoir Hose
c - Wooden Dowel
d - Steering Link Rod
e - Trim Position Sender Leads and Trim Limit Switch Leads
f - Trim Hoses
g - Cork Gasket

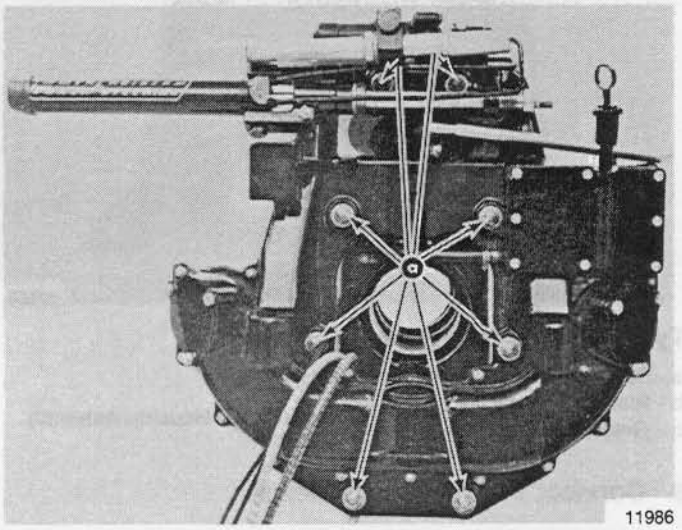


11839

a - Exhaust Tube Pilot (Lubricate with 2-4-C Marine-Lube)

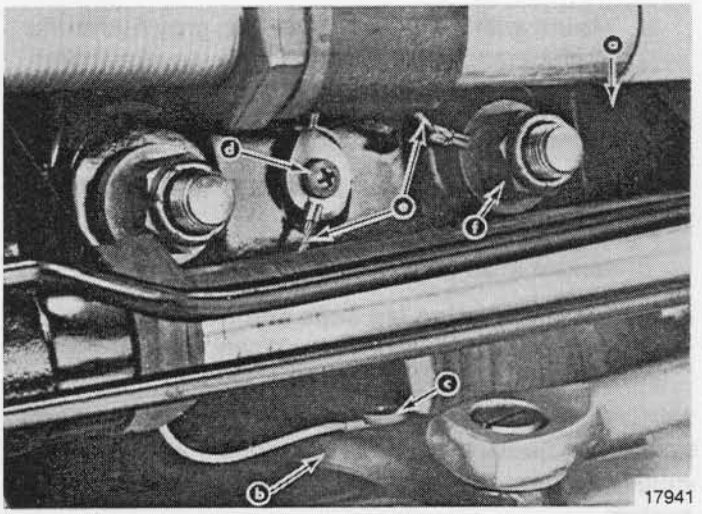
3. While holding gimbal housing in place, insert steering link rod, oil reservoir hose and trim leads and hoses thru openings in inner transom plate and install plate over gimbal housing studs.

4. Fasten gimbal housing and inner transom plate to transom with 8 flat washers and elastic stop nuts. Tighten nuts evenly (starting from center and working outward) until a torque of 25-30 lbs. ft. (34-41 N.m) is attained.



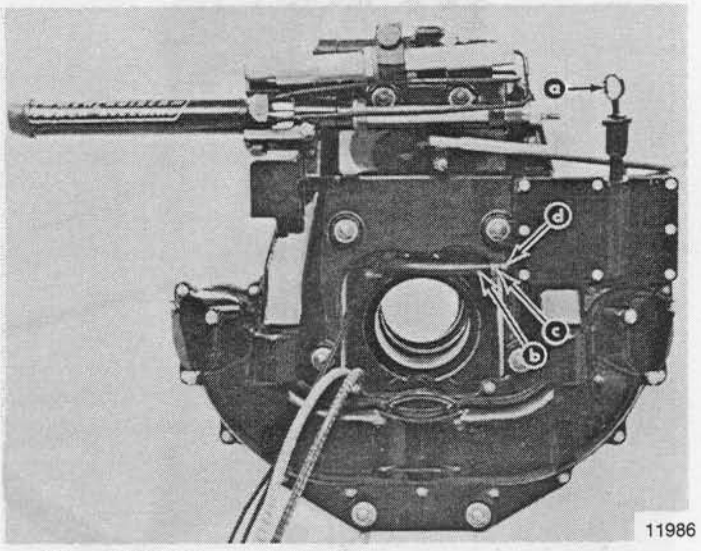
a - Flat Washers and Elastic Stop Nuts [Torque to 25-30 Lbs. Ft. (34-41 N.m)]

5. Connect inner transom plate ground wires. (if equipped)



a - Inner Transom Plate
b - Steering Lever
c - Slotted Screw
d - Ground Screw
e - Ground Wire
f - Locknut

6. Remove wooden dowel from drive unit oil reservoir hose and connect hose to oil reservoir barbed fitting. Be sure to tighten hose clamp securely.



a - Drive Unit Oil Reservoir Dipstick
b - Drive Unit Oil Reservoir Hose
c - Hose Clamp
d - Reservoir Barbed Fitting

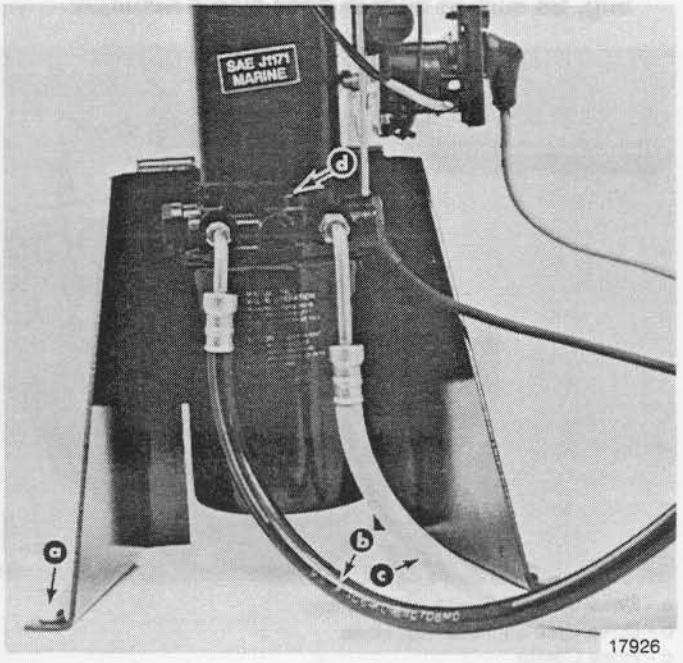
NOTE: If boat will not be equipped with the optional trim position indicator, wrap up the trim position sender leads and secure with a sta-strap. Trim position sender leads are those with ring terminal connectors on the ends. Do not wrap up trim limit switch leads which have bullet connectors on the ends.

7. Select an appropriate mounting location for the trim pump that meets the following requirements.
   a. Mount within limits of black and gray hydraulic hoses (coming from gimbal housing assembly).
   b. Mount close to the battery so that trim pump battery leads can be connected.
   c. Mount to allow easy access to the "Fill/Vent" screw.
   d. Mount in an area not be exposed to water.
8. Mount pump using lag bolts and flat washers and connect hydraulic hoses, as shown.

IMPORTANT: Power Trim system is filled with oil and air-bled at the factory. Make hydraulic connections as quickly as possible to prevent oil from leaking out of system.

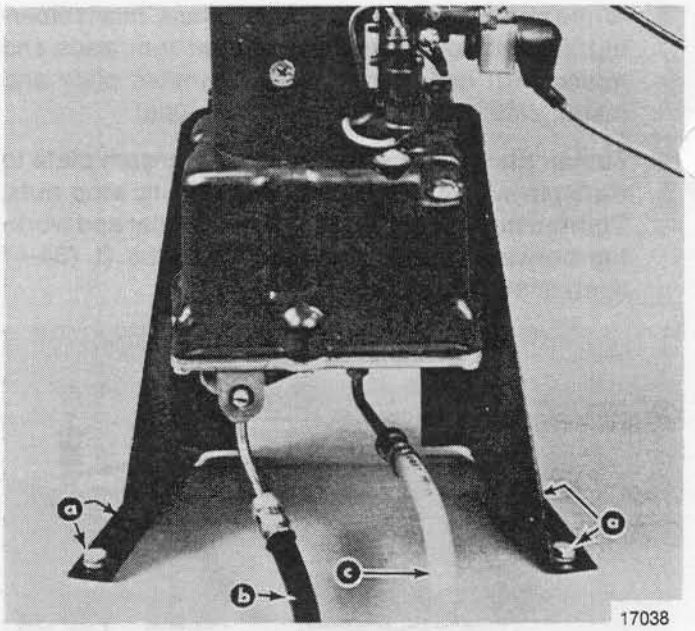
⚠CAUTION
Be careful not to cross-thread or over-tighten hose fittings.

"Fill/Vent" screw must be backed out 1 full turn (after bottoming out) to vent pump reservoir. Failure to back screw out could cause damage to pump.



Oildyne Pump

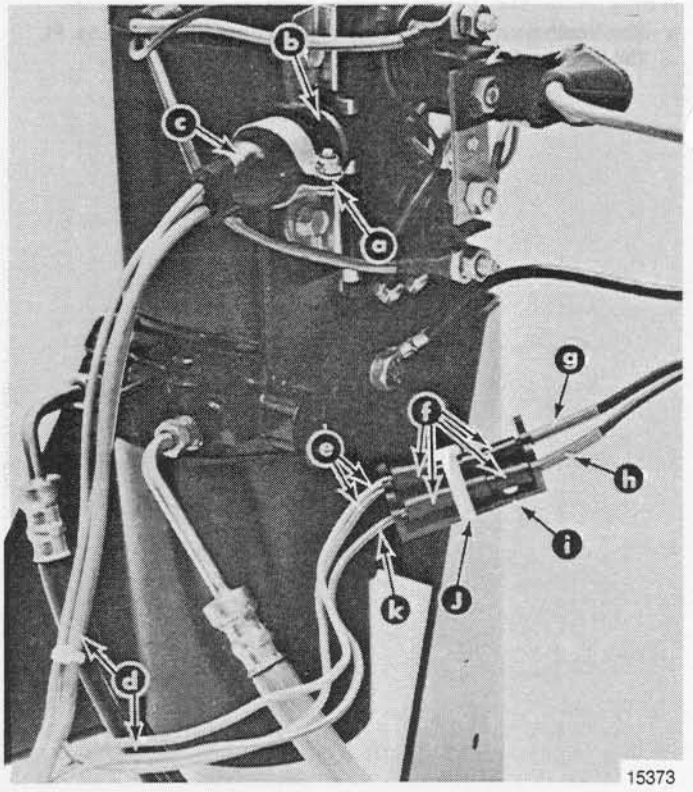
a - Lag Bolts and Flat Washers
b - Black Hydraulic Hose —┐
c - Gray Hydraulic Hose —┘— From Gimbal Housing Assembly
d - "Fill/Vent" Screw (MUST BE Backed Out 1 Full Turn)



Typical Prestolite Power Trim Pump

a - Secure Pump with Lag Bolts and Washers
b - Black Hydraulic Hose —┐
c - Gray Hydraulic Hose —┘— From Gimbal Housing Assembly

9. Connect trim limit switch leads.



a - Clamp, Screw and Locknut
b - Receptacle
c - Wiring Harness Connector
d - Trim Control Wiring Harness
e - Blue-White Wiring Harness Leads
f - Bullet Connectors
g - Trim Limit Switch Lead with Blue Sleeve
h - Trim Limit Switch Lead with Purple Sleeve
i - Connection Retainer
j - Sta-Strap
k - Purple-White Wiring Harness Lead

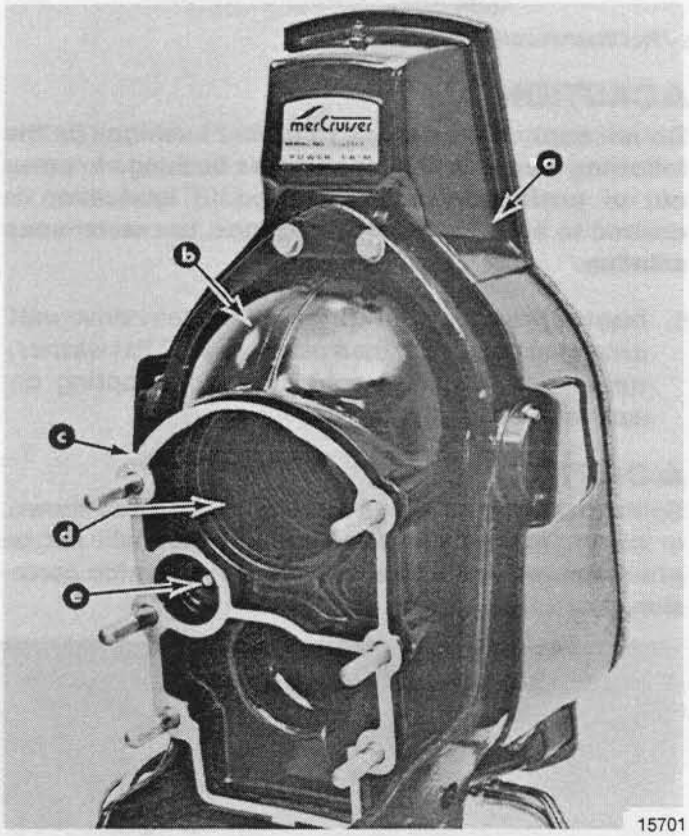
ENGINE INSTALLATION and ALIGNMENT

Refer to appropriate engine installation manual.

STERN DRIVE UNIT

IMPORTANT: DUAL INSTALLATIONS ONLY -- It is recommended that right-hand rotation drive unit (marked "RH" on end of propeller shaft) be installed on starboard (right) transom gimbal housing assembly and left-hand rotation drive unit (without any markings on end of propeller shaft) be installed on port (left) transom gimbal housing assembly. Drive units can be reversed; however, if desired on dual installations with side-by-side engines. On dual installations with staggered engine, drive units cannot be reversed, as units have different universal joint shafts. Installation procedure for both drive units is the same.

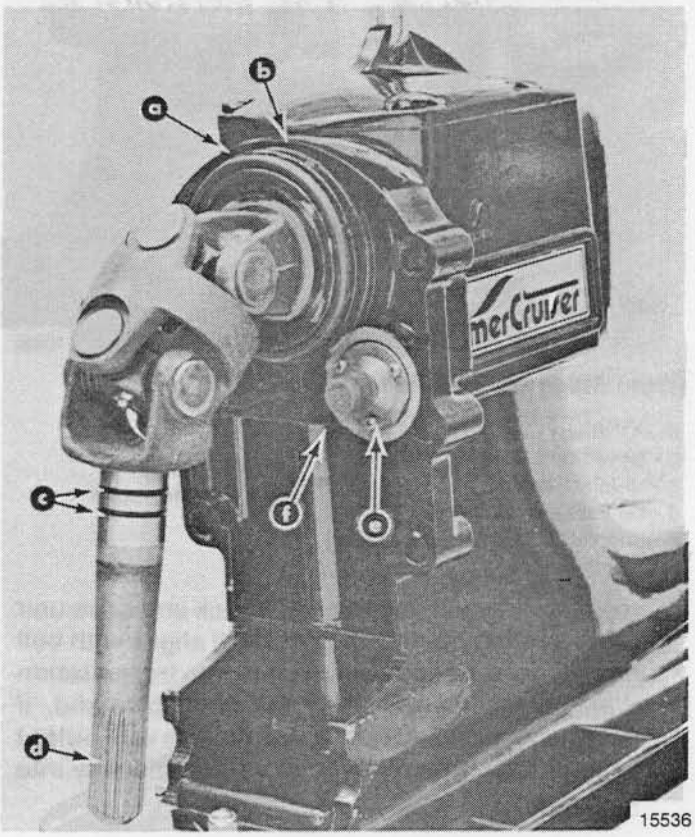
1. Place gasket in position on bell housing. Also, lubricate bell housing bore and oil passage connector with Quicksilver 2-4-C Marine-Lube.



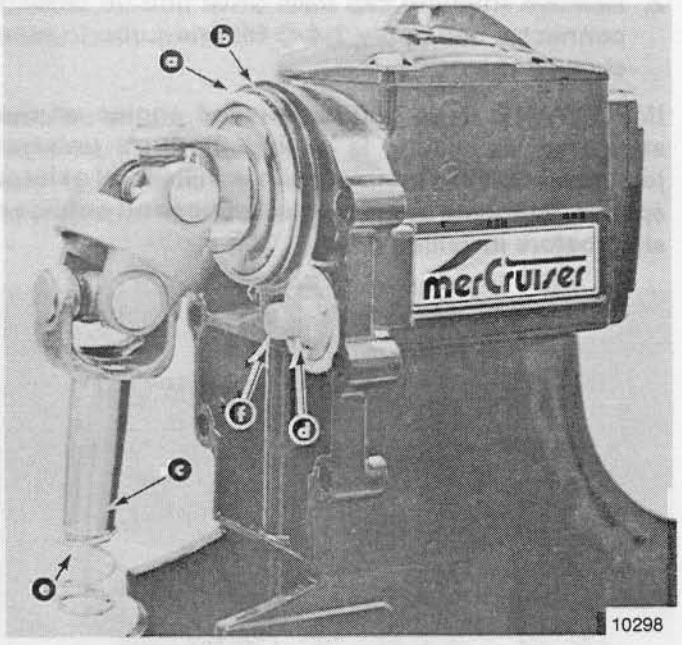
a - Gimbal Housing Assembly
b - Bell Housing
c - Gasket
d - Bell Housing Bore
e - Oil Passage Connector
— Lubricate with 2-4-C Marine—Lube

2. Remove shipping cap from drive unit oil passage connector and apply 2-4-C Marine-Lube to areas shown.

IMPORTANT: Drive unit for forward engine on dual staggered installation is equipped with a universal joint shaft that has internal splines instead of external splines. Lubricate both internal splines and outside of shaft before installing drive.



a - Pilot "O" Ring
b - Drive Shaft Housing Pilot
c - U-Joint Shaft "O" Rings
d - U-Joint Shaft Splines
e - Oil Passage Connector
f - Shipping Cap
— Lubricate with 2-4-C Marine Lube

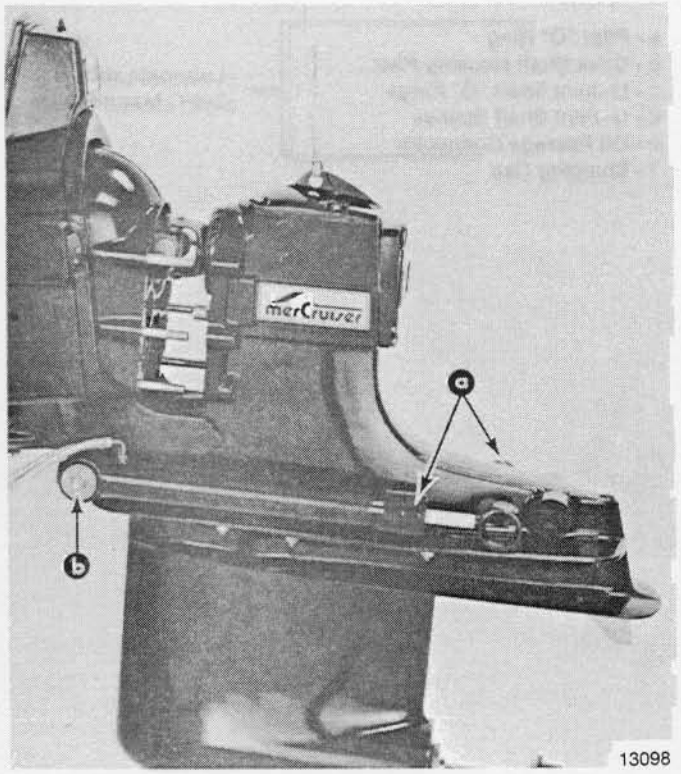


(Dual Staggard Installations)

a - "O" Ring
b - Drive Shaft Housing Pilot
c - U-Joint Shaft
d - Oil Passage Connector
e - Internal Splines
f - Shipping Cap

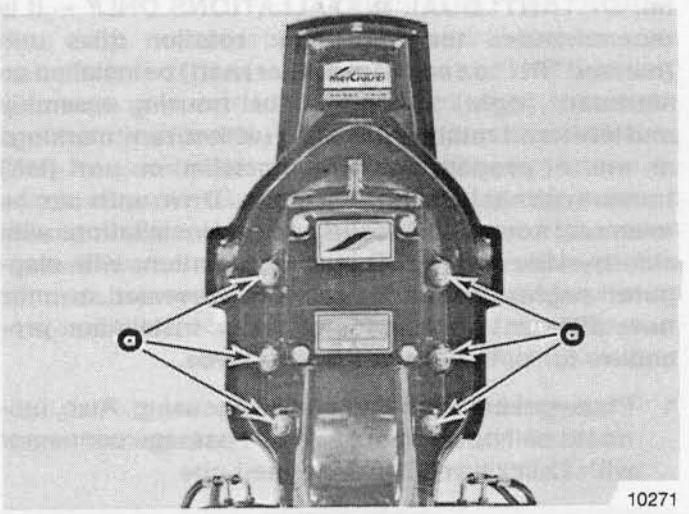
Lubricate with 2-4-C Marine Lube

3. Position trim cylinders straight back and drive unit (using a hoist) so that U-joint shaft aligns with bell housing bore. Guide U-joint shaft into transmission output shaft. Rotate propeller shaft by hand, if necessary, to align U-joint shaft splines with output shaft splines; then push drive unit all-the-way into bell housing.



a - Trim Cylinders b - Forward Anchor Pin

4. Lubricate threads on bell housing studs with 2-4-C Marine-Lube (to prevent threads from galling); then install 6 flat washers and elastic stop nuts (retained in Step 1) on studs. Torque nuts evenly (starting with center nuts and working out) to 80 lbs. ft. (109 N.m).



a - Flat Washers and Elastic Stop Nuts

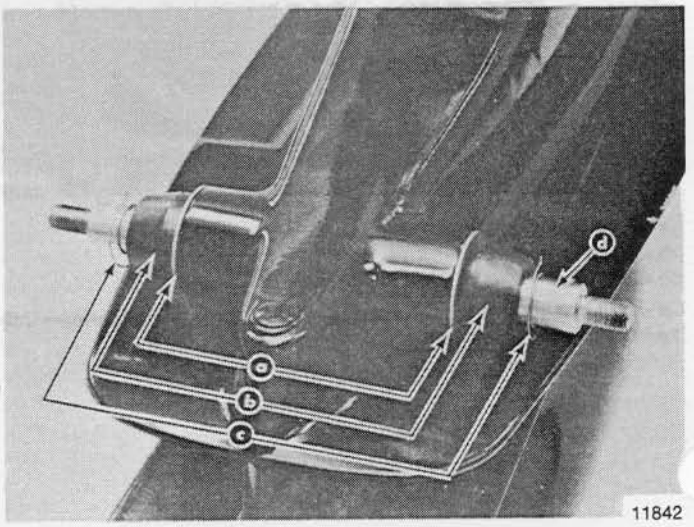
⚠CAUTION

Do not apply oil or grease to rubber bushings (in the following steps), as this may cause bushings to creep out of position during operation. If lubrication is desired to aid in installing bushings, use water soap solution.

5. Insert aft anchor pin thru hole in stern drive unit drive shaft housing; then place large ID flat washer, rubber bushing and spiral grounding spring on each end of pin, as shown.

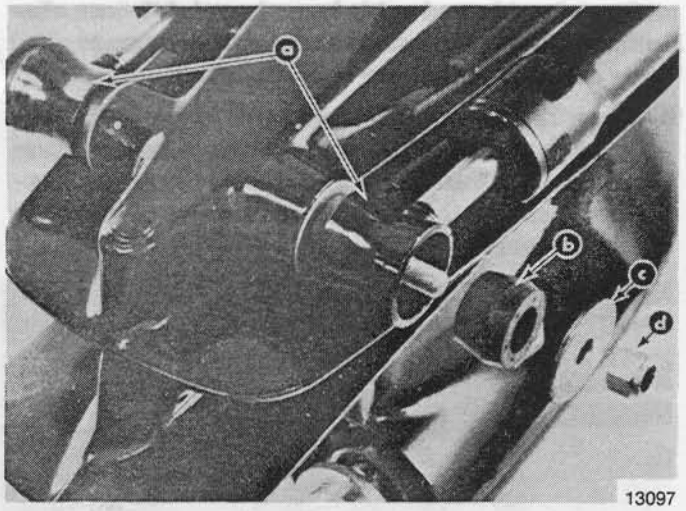
⚠CAUTION

Spiral grounding springs must be installed as shown, or piston rod and pivot end assemblies will not be grounded and could be damaged by galvanic corrosion.



a - Large ID Flat Washers
b - Rubber Bushings
c - Spiral Grounding Springs
d - Aft Anchor Pin

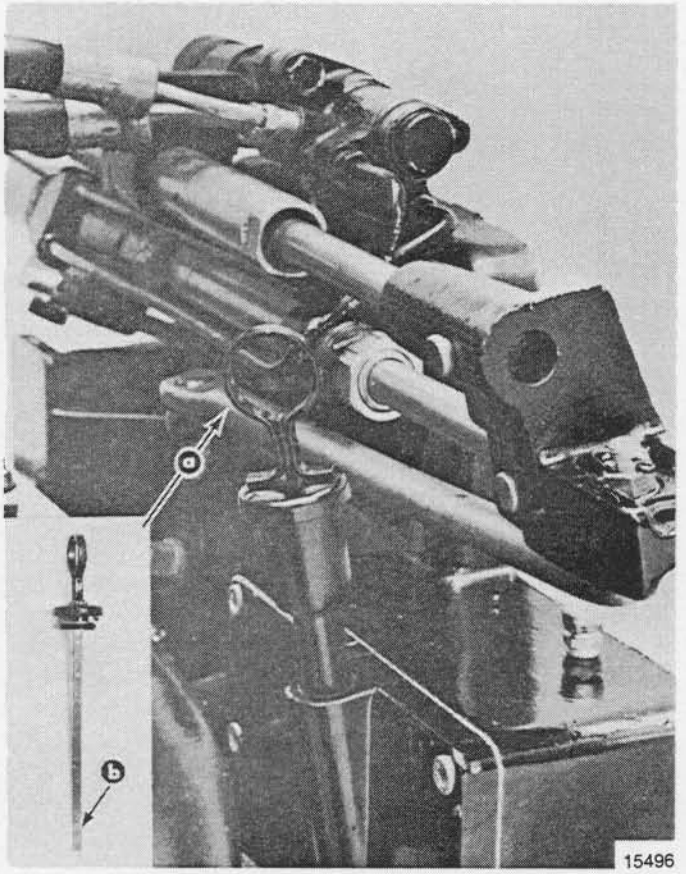
6. Lubricate anchor pin threads with 2-4-C Marine-Lube and assemble as shown.



a - Trim Cylinder Aft Pivot Ends
b - Rubber Bushings (One Each Side)
c - Small ID Flat Washer (One Each Side)
d - Elastic Stop Nut (One Each Side)

7. Tighten forward and aft anchor pin nuts until approximately 2 threads are exposed thru each nut. Do not over-tighten nuts, as rubber bushings may be damaged.

8. Remove dipstick from drive unit oil reservoir and fill reservoir with Super-Duty Lower Unit Lubricant (provided) until level reaches "F" (full) mark on dipstick. Recheck level after first use.

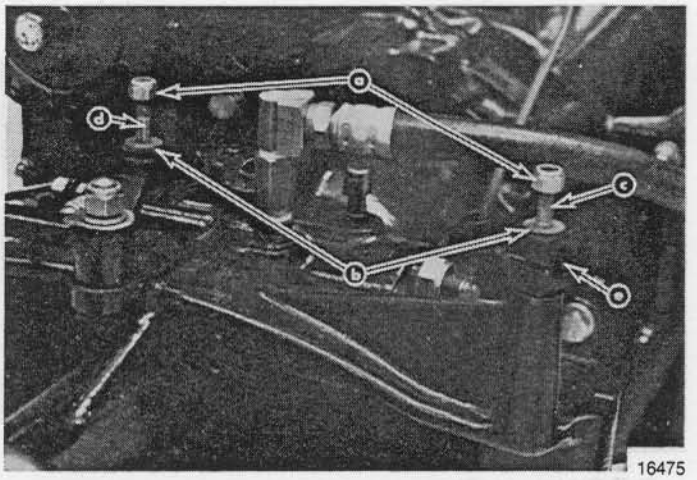


a - Dipstick b - "F" (Full) Mark

Shift Cable Installation and Adjustment

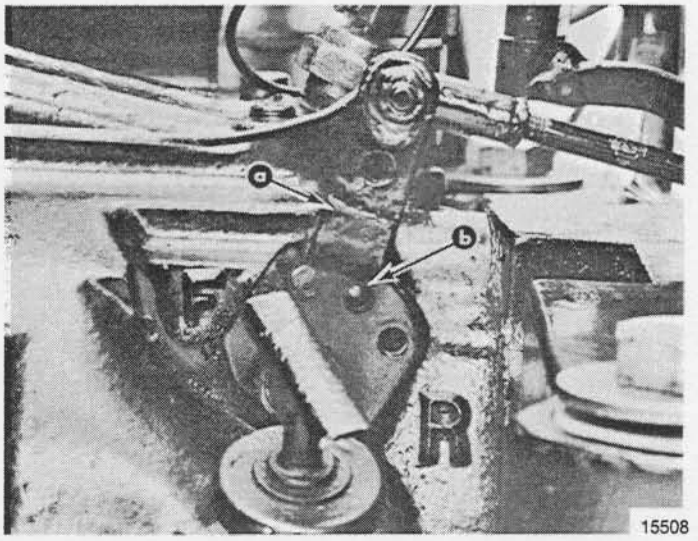
1. Place remote control lever (shift lever) in neutral position.

2. Remove elastic stop nuts, shift cable barrel clamp block and flat washers from transmission shift cable lever stud and shift cable anchor stud.



a - Elastic Stop Nuts
b - Flat Washers
c - Shift Cable Anchor Stud (Measure Shift Cable to this Point)
d - Shift Cable Lever Stud
e - Shift Cable Barrel Clamp Block

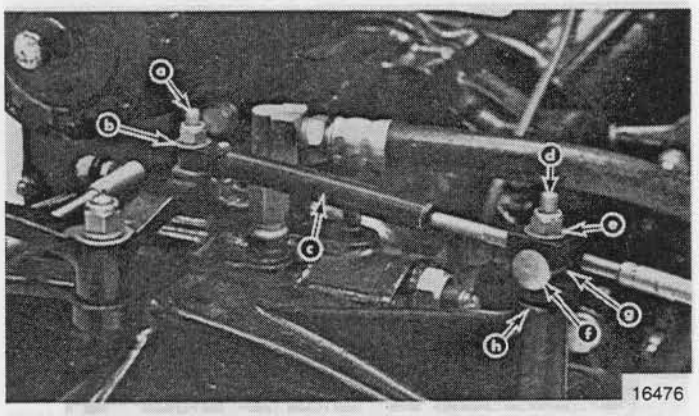
3. Place transmission shift lever in neutral position, indicated when poppet ball (located behind shift lever) is in center detent hole of shift lever.



a - Shift Lever
b - Poppet Ball in Center Hole of Shift Lever

4. Adjust brass barrel on shift cable, as required, to align shift cable attaching holes (in cable end guide and brass barrel) with shift cable lever and shift cable anchor studs. Center the cable end play travel when making adjustment.

5. Install shift cable and secure with flat washers, shift cable barrel clamp block and elastic stop nuts (removed in Step 2). Tighten nuts until they bottom-out; then back off elastic stop nuts 1/2-turn after bottoming out.

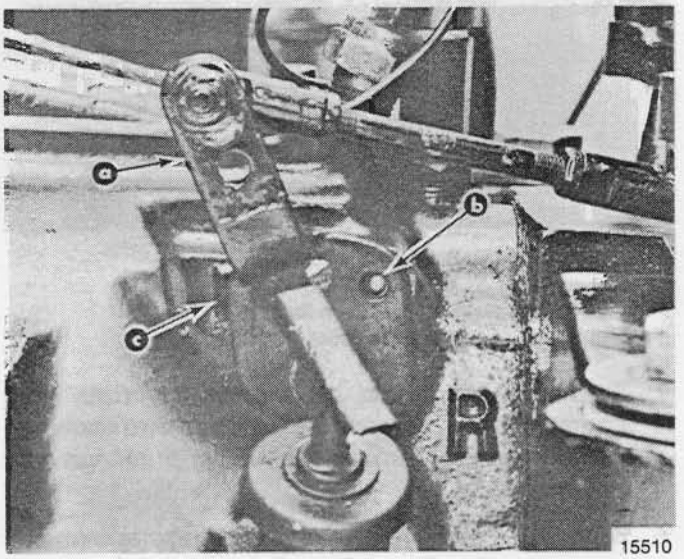


a - Shift Cable Lever Stud
b - Small Flat Washer and Elastic Stop Nut
c - Cable End Guide
d - Shift Cable Anchor Stud
e - Large Flat Washer and Elastic Stop Nut
f - Brass Barrel
g - Shift Cable Barrel Clamp Block
h - Flat Washer

⚠CAUTION

Be sure to back off elastic stop nuts, which secure cable end guide and cable brass barrel, 1/2-turn after bottoming it out. End guide and brass barrel must pivot freely on studs for proper shift operation.

6. Place remote control lever (shift lever) in full forward gear position. Check position of transmission shift lever. Transmission shift lever must be positioned so that the poppet ball is in rear detent hole of shift lever.

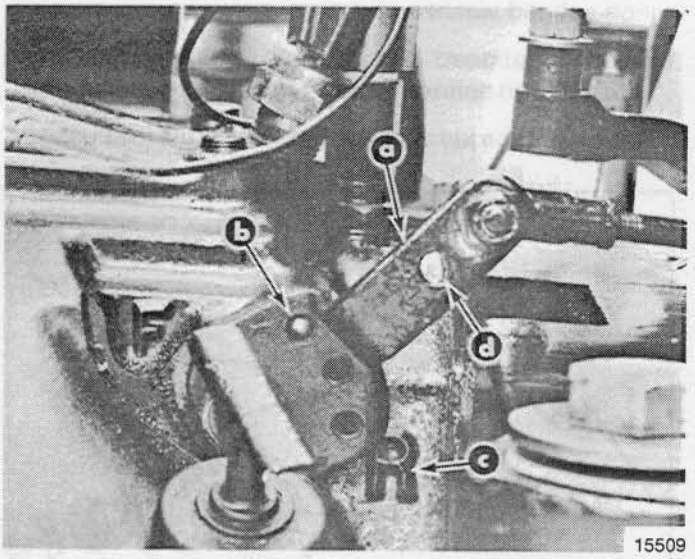


a - Shift Lever
b - Poppet Ball in Rear Detent Hole
c - "F" On Transmission Case

7. Place remote control lever in full reverse gear position and, again, check transmission shift lever position. Poppet ball must be in front detent hole of shift lever.
8. If transmission shift lever is positioned correctly in one gear (forward or reverse), but not in the other, recheck shift cable adjustment. If transmission shift lever is not positioned properly in both gears, move shift rod stud from top hole in transmission shift lever to bottom hole and recheck for proper positioning of shift lever. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

⚠CAUTION

Remote control and shift cable must position transmission shift lever so that it is fully in the forward and reverse gear detent positions and over the letter "F" on transmission case when propelling boat forward. Transmission shift lever must be positioned properly (without any modification to transmission) or transmission failure may occur. Warner Gear Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed; if the shift lever is repositioned or changed in any manner; or remote control and cable do not position shift lever correctly.



a - Shift Lever
b - Poppet Ball in Front Detent Hole
c - "R" On Transmission Case
d - Install Shift Rod Stud in This Hole, If Necessary, to Properly Position Shift Lever with Poppet Ball

Propeller Installation

⚠CAUTION

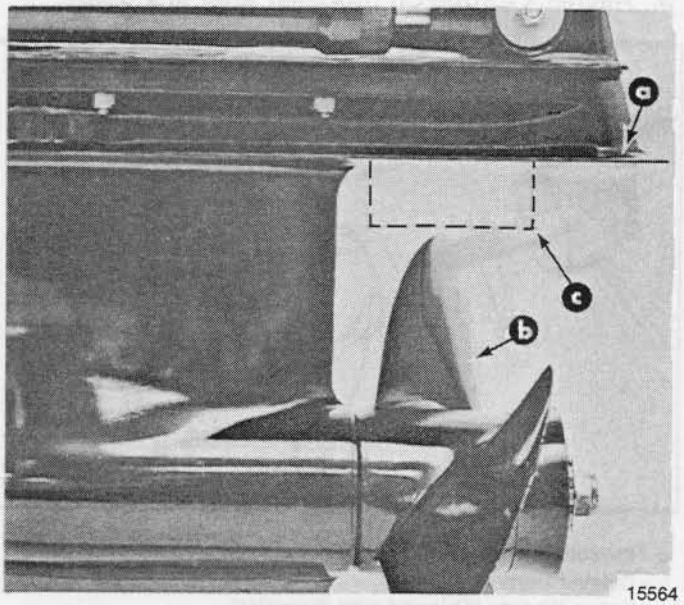
Be sure to use correct rotation propeller. Drive units with propeller shafts that are marked "RH" (on the end) must be equipped with right-hand rotation propellers. Drive units with unmarked propeller shafts must be equipped with left-hand rotation propellers. If incorrect rotation propeller is used, and transmission is run in reverse gear to propel boat forward, transmission failure will occur.

⚠WARNING

Before proceeding with propeller installation, make sure that remote control is in neutral position and ignition key is removed from switch.

⚠WARNING

When installing propeller nut, place a block of wood between the anti-ventilation plate and propeller to protect hands from propeller blades and to prevent propeller from turning.

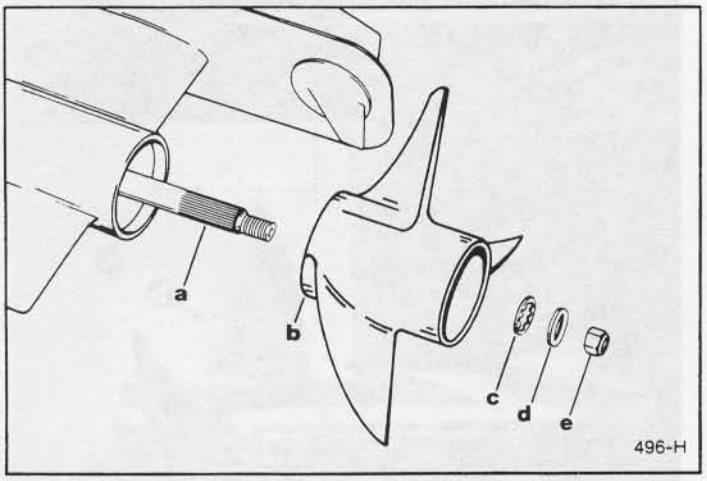


a - Anti-Ventilation Plate
b - Propeller
c - Place Block of Wood Here (Between "a" and "b")

TRS Cleaver Propellers with Solid Drive Hub

IMPORTANT: When using cleaver propellers with solid drive hub, the spline washer and flat washer packaged with propeller must be used in place of splined washer and tab washer shipped with drive unit. Propeller nut shipped with drive unit is used to secure propeller.

1. Apply a liberal coat of Special Lubricant 101, 2-4-C Marine-Lube or Perfect Seal to splines on propeller shaft, to aid in future removal of propeller. This is particularly necessary if boat is to be operated in salty, polluted or mineral-laden waters.
2. Align splines in propeller hub with splines on propeller shaft and slide propeller all-the-way onto shaft.
3. Place spline washer on shaft with concave (hollowed) side facing propeller and engage splines on washer with splines on shaft.
4. Install flat washer and propeller nut. Torque nut to 55 lbs. ft. (75 N.m) minimum.
5. Recheck torque on propeller after first usage.

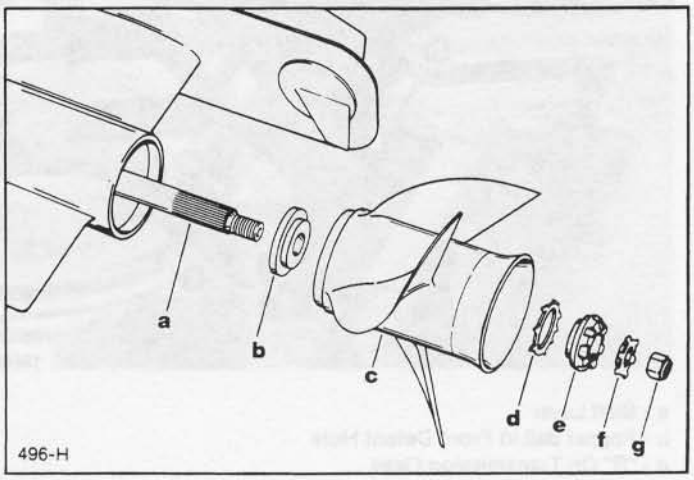


a - Propeller Shaft
b - Cleaver Propeller
c - Spline Washer (Shipped with Propeller)
d - Flat Washer (Shipped with Propeller)
e - Propeller Nut (Shipped with Drive Unit)

TRS Cleaver Propeller with Rubber Drive Hub

IMPORTANT: When using cleaver propellers with rubber drive hub, the front thrust hub packaged with propeller must be used. A splined washer, tab washer and propeller nut also are required and are shipped with drive unit.

1. Apply a liberal coat of Special Lubricant 101, 2-4-C Marine-Lube or Perfect Seal on splines of propeller shaft, to aid in future removal of propeller. This is particularly necessary if boat is to be operated in salty, polluted or mineral-laden waters.
2. Place front thrust hub into front end of propeller hub with stepped-side toward propeller.
3. Align splines in propeller with splines on propeller shaft and slide propeller and thrust hub assembly all-the-way onto shaft.
4. Place continuity and spline washers on propeller shaft and engage splines on washer with splines on shaft.
5. Place propeller nut into recess in tab washer, then thread nut and washer assembly onto propeller shaft. Tighten nut until a minimum torque of 55 lbs. ft. (75 N.m) is attained and continue to tighten until 3 of the tabs on tab washer align with grooves on splined washer.
6. Bend 3 aligned tabs on tab washer down into grooves on splined washer to secure propeller nut.
7. Recheck torque on propeller nut after first usage.



a - Apply Special Lubricant 101 on Splines of Propeller Shaft
b - Forward Thrust Hub
c - Propeller
d - Continuity Washer
e - Spline Washer
f - Tab Washer
g - Tighten Nut Until a MINIMUM Torque of 55 Lb. Ft. 75 N.m) Is Attained and Continue to Tighten Until 3 of the Tabs on Tab Washer Align with Grooves on Spline Washer. Bend 3 Tabs on Tab Washer Down in Grooves in Spline Washer

Quicksilver TR Propeller

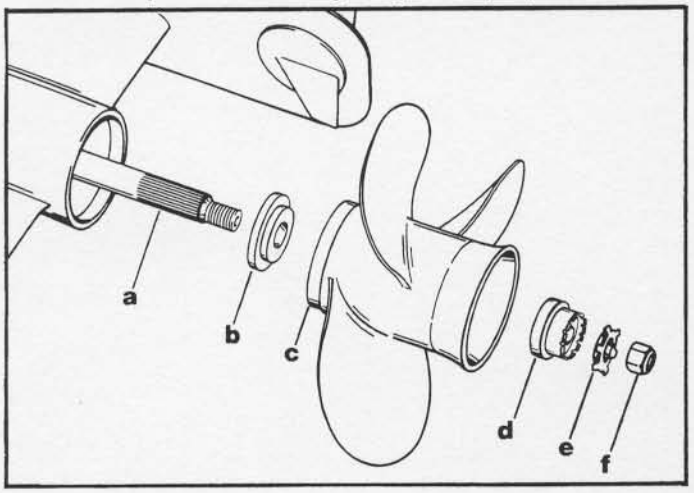
1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Quicksilver lubricants (listed in order of effectiveness):

   —Special Lubricant 101
   —2-4-C Marine-Lube
   —Perfect Seal

2. Place thrust hub-and-washer assembly into front end of propeller hub with shouldered (stepped) side toward propeller hub.
3. Align splines in propeller with splines on propeller shaft and slide propeller and thrust hub-and-washer assembly all-the-way onto shaft.
4. Place splined washer assembly on propeller shaft and engage splines in washer with splines on shaft.

IMPORTANT: If tab washer is to be reused, carefully inspect tabs for cracks or other damage. Tab washer prevents propeller nut from loosening during operation and should be replaced if condition is questionable.

5. Place propeller nut into recess in tab washer and thread nut and washer onto propeller shaft. Tighten nut until a minimum torque of 55 lbs. ft. (75 N.m) is attained; then, continue to tighten nut until 3 of the tabs on tab washer align with grooves on splined washer assembly.
6. Bend 3 aligned tabs on tab washer down into grooves in splined washer assembly to secure propeller nut.
7. Recheck propeller nut torque after first use and periodically thereafter. Be sure to rebend tabs on tab washer, down into grooves in splined washer assembly after checking torque on propeller nut.



a - Propeller Shaft
b - Thrust Hub and Washer Assembly
c - Propeller
d - Splined Washer Assembly
e - Tab Washer
f - Propeller Nut

In Service Preparation and Adjustments

FILLING and BLEEDING POWER TRIM SYSTEM

Refer to Section 5.

TRIM LIMIT SWITCH ADJUSTMENT

Refer to Section 4.

TRIM POSITION SENDER ADJUSTMENT

Refer to Section 4.

FILLING and BLEEDING POWER STEERING SYSTEM

Refer to Section 5.

BALANCING POWER STEERING CONTROL VALVE

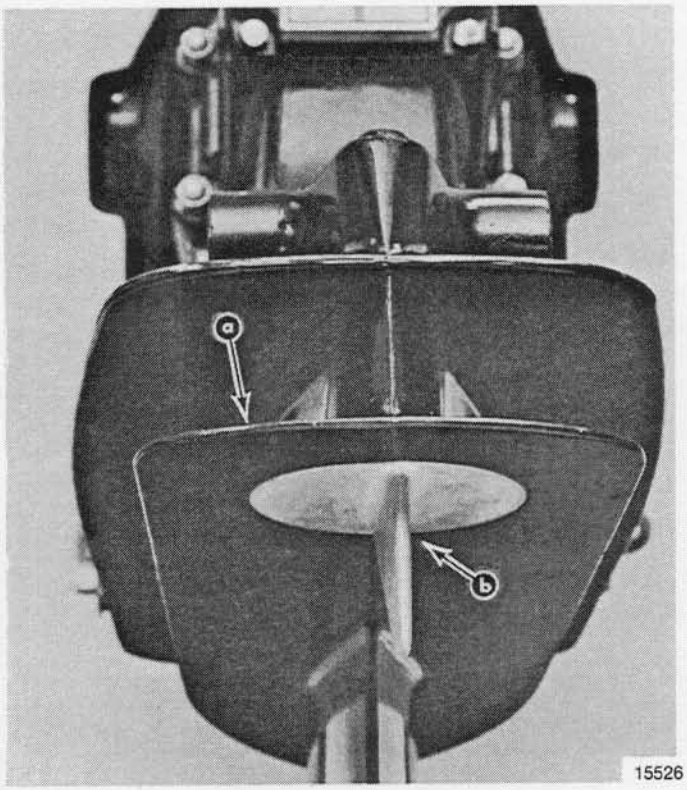
Refer to Section 6A.

CHECKING POWER STEERING FOR LUGGING CONDITION

Refer to Section 6A.

TRIM TAB ADJUSTMENT

Set zinc alloy tab (on bottom of anti-ventilation plate -- with the trailing edge straight back. See Section 1-B, "Trim Tab Replacement".

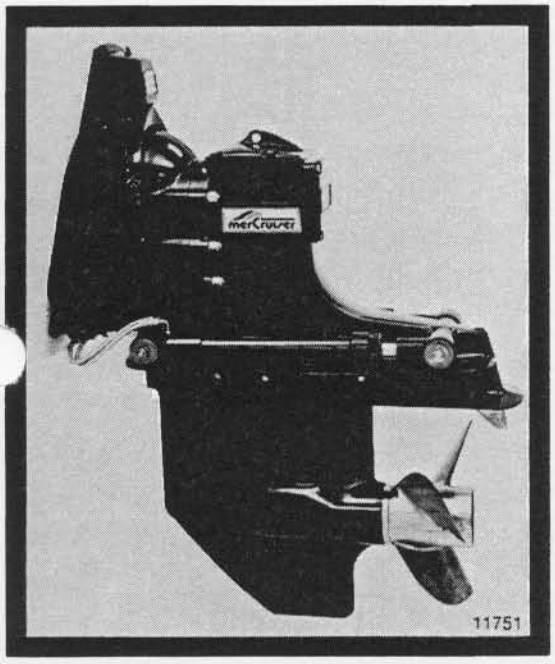


a - Anti-Ventilation Plate
b - Trim Tab

STERN DRIVE UNIT

3

A



GENERAL INFORMATION

mercruiser
STERN DRIVES & INBOARDS

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Specifications

GEAR RATIOS

Model	Overall Gear Ratio	Drive Shaft Housing Gear Teeth No. (Drive/Driven)	Gear Housing Gear Teeth No. (Drive/Driven)
TR Standard	2:1	24/32	16/24
TR Commercial	1.5:1	17/17	16/24
TRS	1.5:1	24/32	16/16

LUBRICANT CAPACITY

TR	*4 Qts.
TRS	*3 Qts.

*Approximate

Special Tools

Part No.	Description
91-26150	Lubricant Pump

Description

The stern drive unit is comprised of a drive shaft housing and a gear housing. Refer to specific subsection, following for a description of each.

Drive Unit Lubricant

NOTE: Refer to Section 1 for maintenance intervals.

REQUIREMENTS

Use only Quicksilver Super-Duty Lower Unit Lubricant. DO NOT use regular automotive grease, as damage to bearings and gears may result.

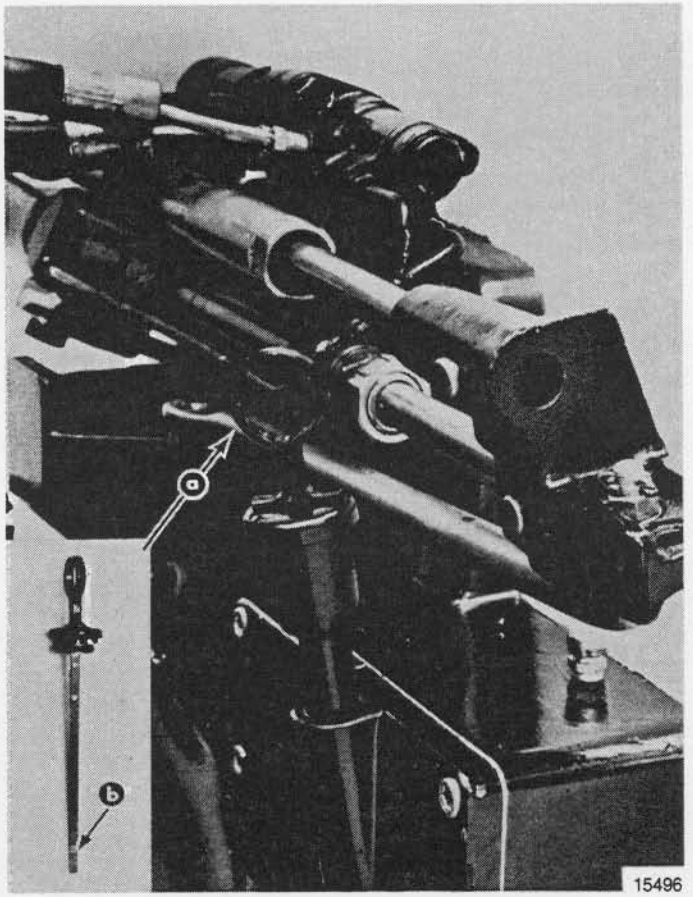
MAINTAINING LUBRICANT LEVEL

⚠CAUTION

If lubricant on dipstick appears milky brown or is not visible on dipstick, a leak in drive unit is indicated. Cause for leak should be found, and corrected and unit should be refilled with fresh lubricant, before using.

If lubricant level is below dipstick, DO NOT attempt to fill drive unit thru reservoir dipstick tube, as air may be trapped in drive unit and unit may be damaged from lack of lubrication. After cause for low lubricant level has been found and corrected, refill drive unit with lubricant, as outlined under "Changing Lubricant," following.

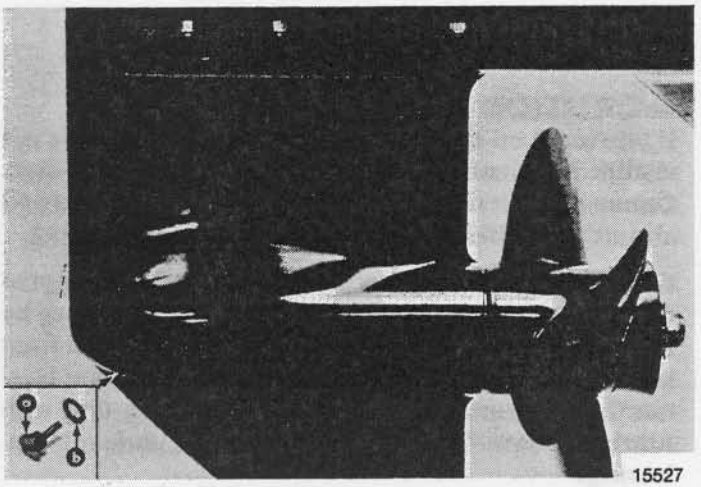
Check lubricant level with reservoir dipstick (a) on inner transom plate. Be sure to push dipstick all-the-way down into dipstick tube before taking reading. If oil level is below "F" ("full" mark, add lubricant, as required to bring level up to Mark).



a - Dipstick
b - "F" (Full) Mark

CHECKING LUBRICANT FOR WATER

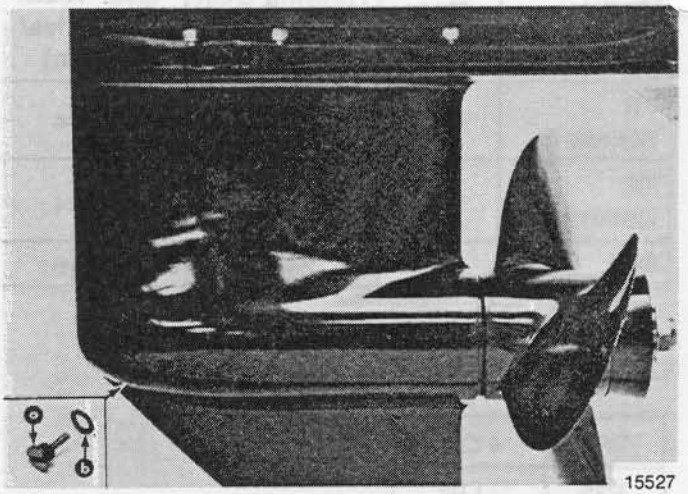
Lubricant should be inspected for water periodically, to ensure that the drive unit seals are not leaking. To check for water, trim drive unit to full "Out" position and remove fill/drain plug to take a sample (1 teaspoon). If any water is observed or if lubricant appears milky brown, drive unit is leaking and must be resealed.



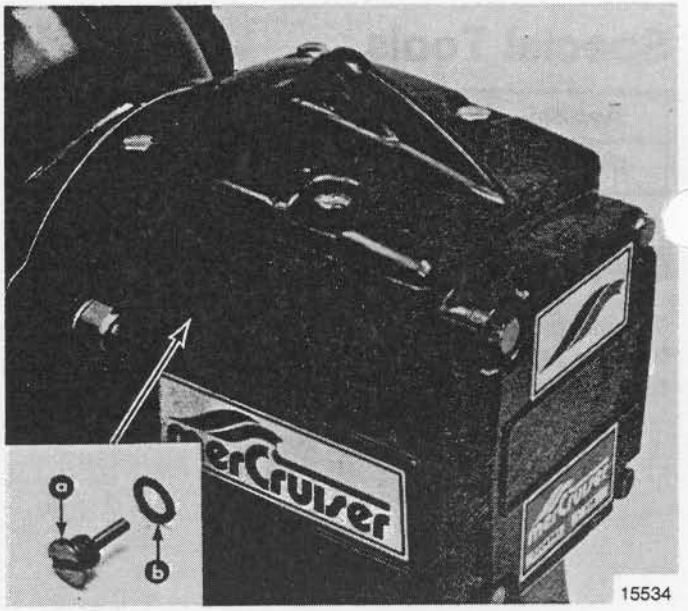
a - Fill/Drain Plug
b - Sealing Washer

CHANGING LUBRICANT

1. Trim drive unit to full "Out" position.
2. Remove fill/drain plug and vent plug and allow unit to drain completely.



a - Fill/Drain Plug
b - Sealing Washer (Replace if Damaged)



a - Vent Plug
b - Sealing Washer (Replace if Damaged)

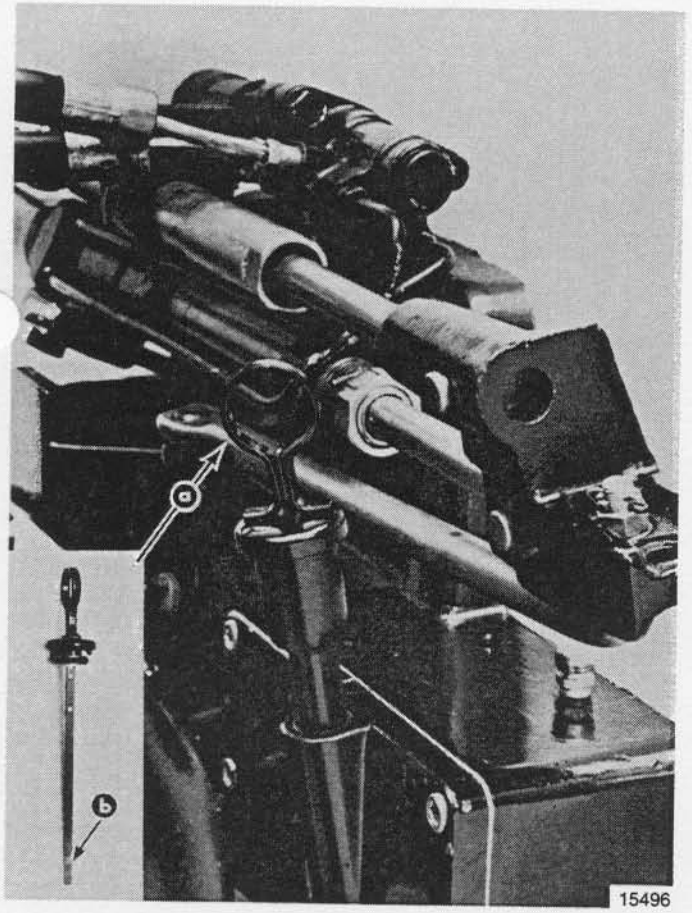
3. Reinstall vent plug (with sealing washer) and tighten securely.

⚠CAUTION

Drive unit must be filled thru the fill/drain hole. DO NOT attempt to fill thru dipstick tube or vent hole, as air will be trapped in drive unit and unit will be damaged from lack of lubrication.

4. Position drive unit so that anti-ventilation plate is level. Inject lubricant thru oil fill/drain hole, using lubricant pump 91-26150, until oil level reaches "F" mark on dipstick.

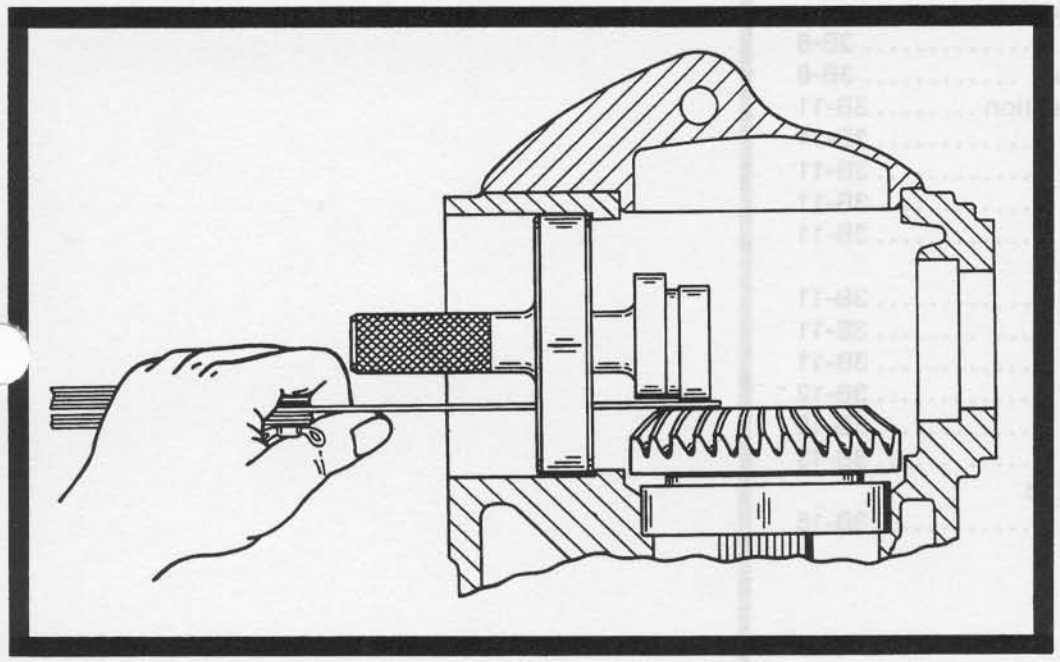
Approximate Lubricant Capacity	
TR	4 Qts.
TRS	3 Qts.



a - Dipstick
b - Fill with Lubricant to "F" Mark

5. Quickly reinstall fill/drain plug (with washer) and tighten securely.
6. Recheck oil level after first use.

STERN DRIVE UNIT



3

B

DRIVE SHAFT HOUSING

mercruiser
STERN DRIVES & INBOARDS

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Specifications

Torques

Rear Cover Screws	20 Lbs. Ft. (27 N.m)
Top Cover Screws	20 Lbs. Ft. (27 N.m)
U-Joint Shaft Nut	200 Lbs. Ft. (271 N.m)

Upper Drive Shaft Bearing Preload

New Bearings	5-15 Lbs. In.
*Used Bearings	2-6 Lbs. In.

* Bearings are considered used if spun under load once.

U-Joint Shaft Bearing Preload (Drive Shaft Housing Overall)

With 24/32 Tooth Gears	•New Bearings	5-11 Lbs. In., Plus Upper Drive Shaft Bearing Preload
	*•Used Bearings	2-4 Lbs. In., Plus Upper Drive Shaft Bearing Preload
With 17/17 Tooth Gears	•New Bearings	4-8 Lbs. In., Plus Upper Drive Shaft Bearing Preload
	*•Used Bearings	2-3 Lbs. In., Plus Upper Drive Shaft Bearing Preload

- New or used condition refers to U-joint shaft and drive gear bearings only.

* Bearings are considered used if spun under load once.

Special Tools

Part Number	Description
91-32610	Torque Wrench (0-200 Lbs. Ft.)
91-34569A1	Slide Hammer Puller
91-37241	Universal Puller Plate
91-38756	Adaptor
91-63619	Driver
91-63620A1	Bearing Wrench and Drive Shaft Socket
91-63625	Bearing Holder
91-63626	Driver
91-66274	Torque Wrench (0-150 Lbs. In.)
*91-98171	Shimming Tool, Driven Gear
†91-99924	Shimming Tool, Drive Gear

*Supercedes 91-63623
†Supercedes 91-63624

Lubricants, Adhesives and Sealers

- Quicksilver 2-4-C Multi-Lube, 92-90018A12
- Quicksilver Bellows Adhesive, 92-86166 or Adhesive Glue, 92-25234-1
- Quicksilver Super-Duty Lower Unit Lubricant (*)
- Quicksilver Loctite "A", 92-32609

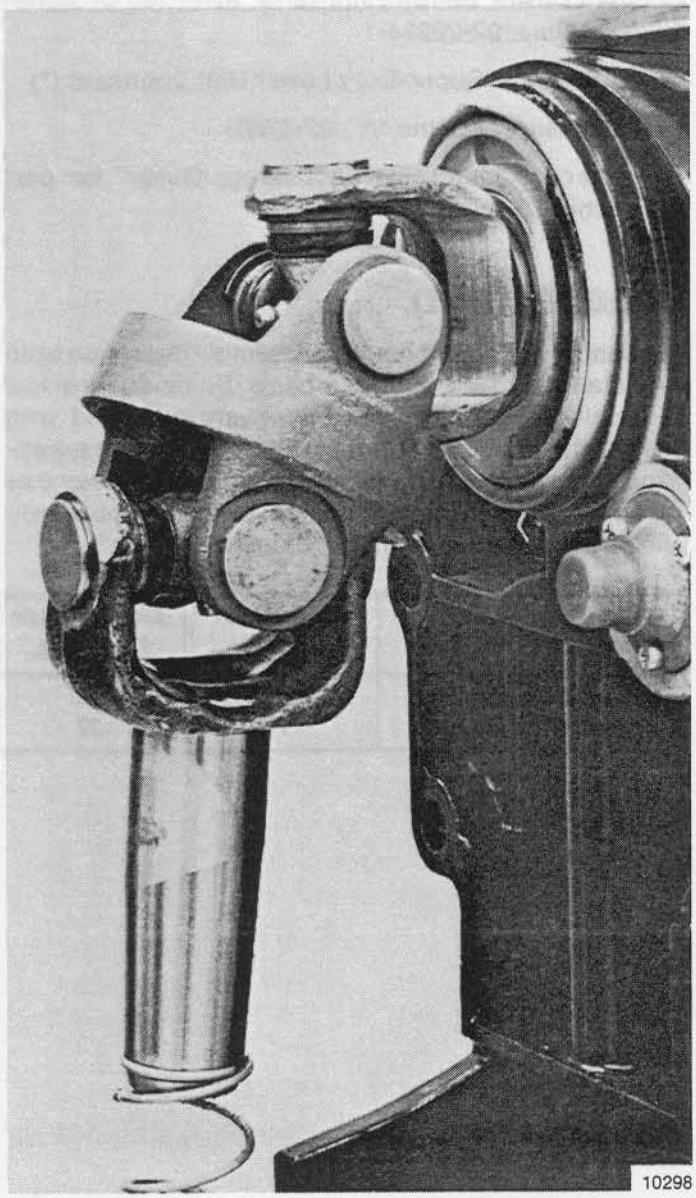
* Refer to "Quicksilver Accessory Guide" for part number.

Description

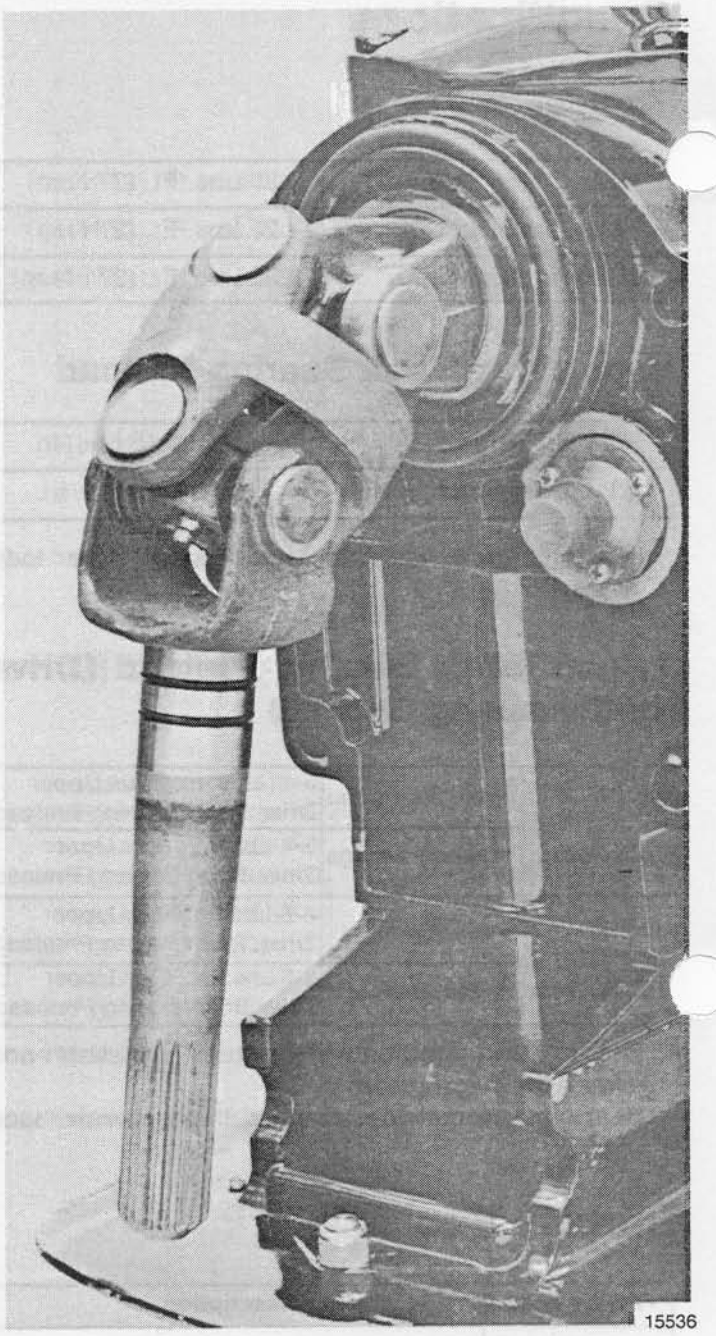
The same drive shaft housing assembly is used on both the standard TR and TRS models. Some commerical TR units (used mainly overseas) are equipped with heavy-duty drive shaft housing gears. With the exception of the gears, all other components are the same as the standard drive shaft housing. Gears can be identified by counting the number of teeth.

	Drive Gear Teeth No.	Driven Gear Teeth No.
Standard Gears	24	32
Heavy-Duty Gears	17	17

Two different U-joint coupling end yokes are utilized depending on which transmission is being used. On models with a drive shaft between the engine and the drive, the "Mercury Marine Transmission Type "U-joint yoke used.

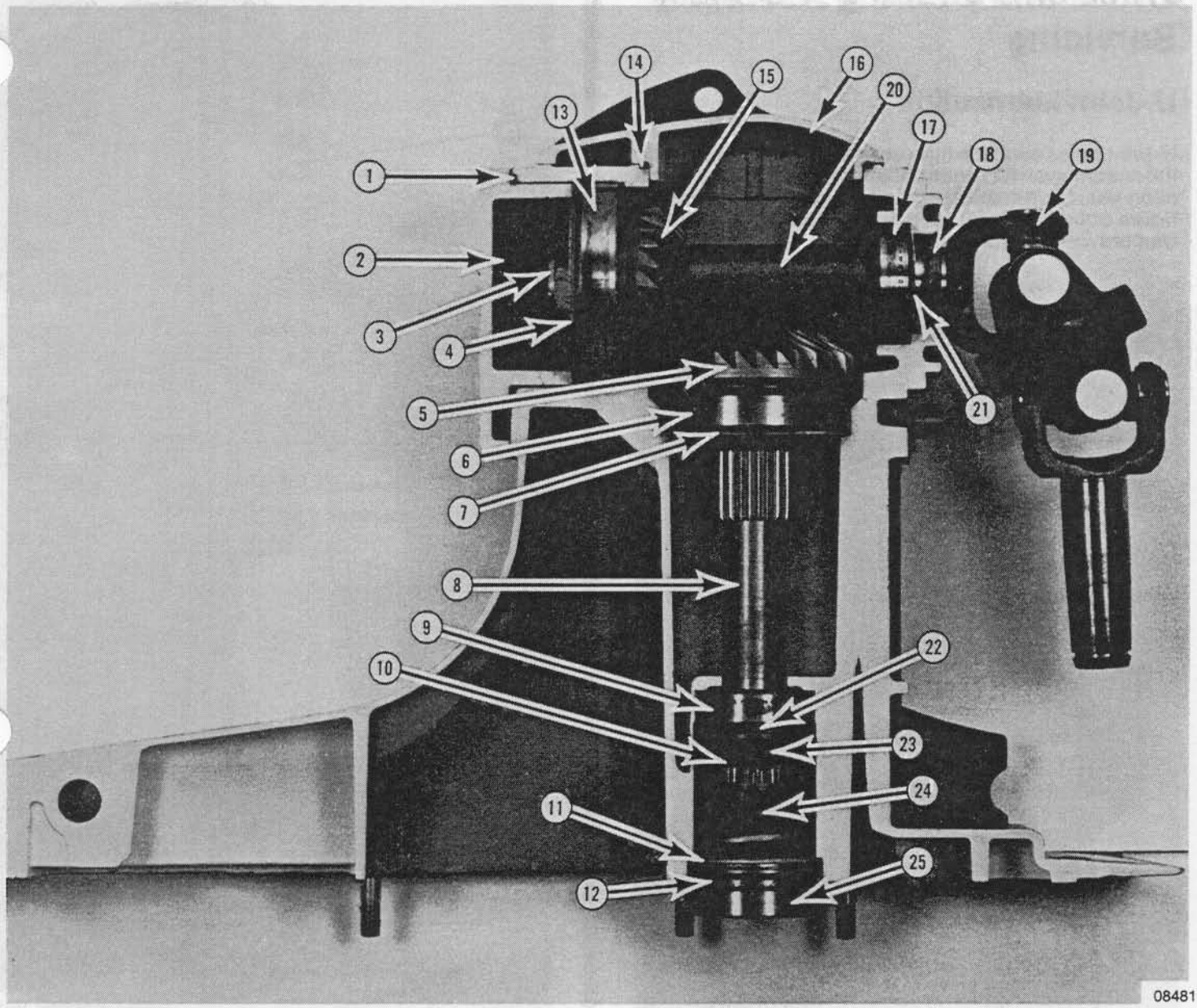


Mercury Marine Transmission Type U-Joint Yoke



Borg Warner Transmission Type U-Joint Yoke

Component Parts

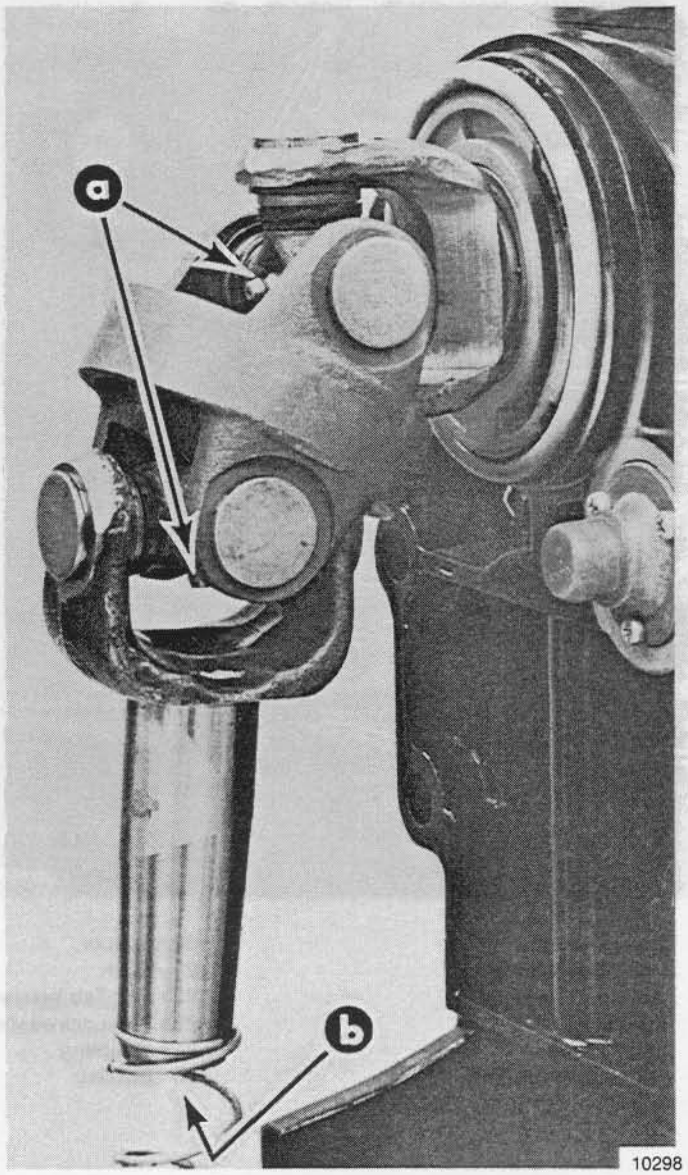


1 - "O" Ring
2 - Rear Cover
3 - Nut
4 - Shim and Tab Washer
5 - Driven Gear
6 - Bearing
7 - Shim
8 - Upper Drive Shaft
9 - Bearing
10 - Bearing Nut
11 - Shim
12 - "O"Ring
13 - Bearing
14 - "O" Ring
15 - Drive Gear
16 - Top Cover
17 - Bearing
18 - Oil Seal
19 - U-Joint Assembly
20 - Spacer
21 - Shim
22 - Flat Tab Washer
23 - Tab Lockwasher
24 - Coupling
25 - Bearing

U-Joint Coupling End Yoke/ Cross and Bearing Assembly Servicing

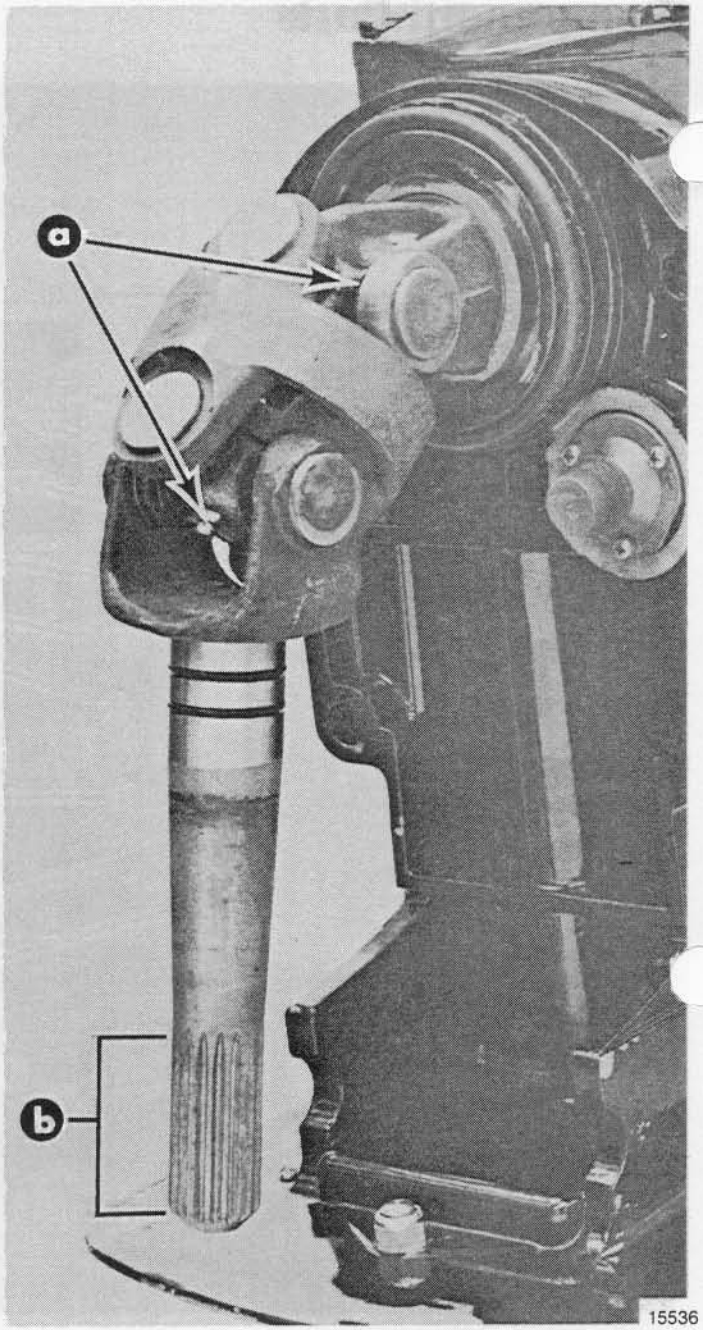
U-Joint Lubrication

U-joint cross and bearings and yoke splines should be lubricated ever 100 hours of operation or at least once each year. Lubrication should be performed every 50 hours of operation if unit is used primarily for trolling. Use only 2-4-C Multi-Lube.



a - Cross and Bearing Grease Fittings
b - Yoke Splines (Internal)

Lubrication Points - Mercury Marine Transmission Type U-Joint



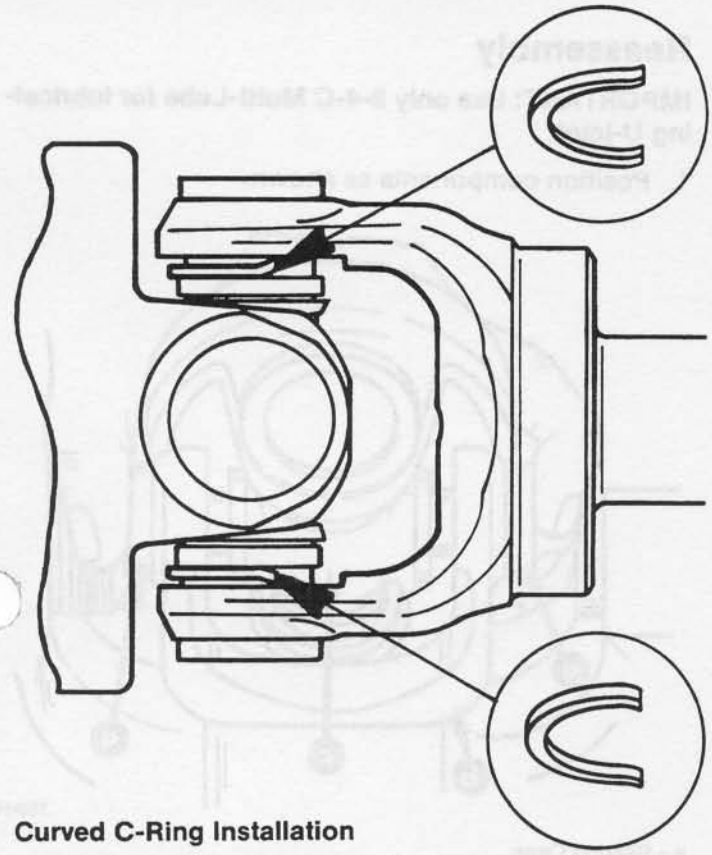
a - Cross and Bearing Grease Fittings
b - Yoke Splines

Lubrication Points - Borg Warner Transmission Type U-Joint

Inspection - Pre-Disassembly

1. Check cross and bearing for roughness, excessive side-to side play.

NOTE: Excessive side-to-side play in cross and bearings can cause U-joint knocking. This condition can sometimes be eliminated by installing C-Ring Kit, 53-12067A1. Kit contains 8 curved C-rings. These C-rings are used as standard equipment on later production units. Curved rings cannot be used with replacement cross and bearing assembly, 41431.



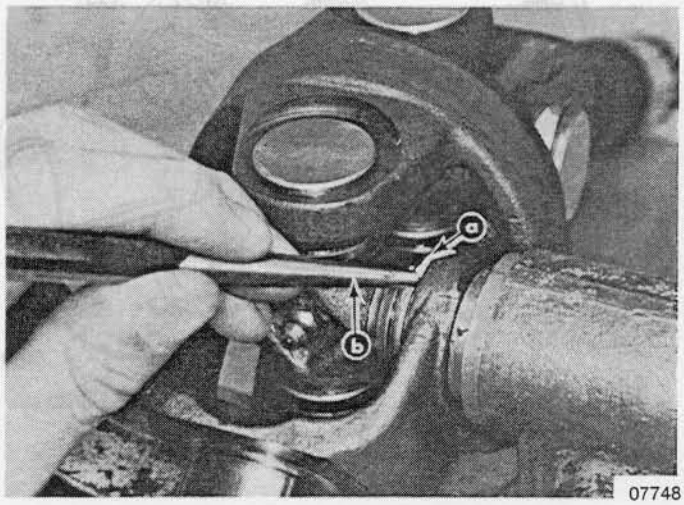
Curved C-Ring Installation

2. Check splines on coupling end yoke for wear.
3. If troubleshooting a U-joint knocking condition, inspect for evidence of bearing caps hitting center socket.

Disassembly

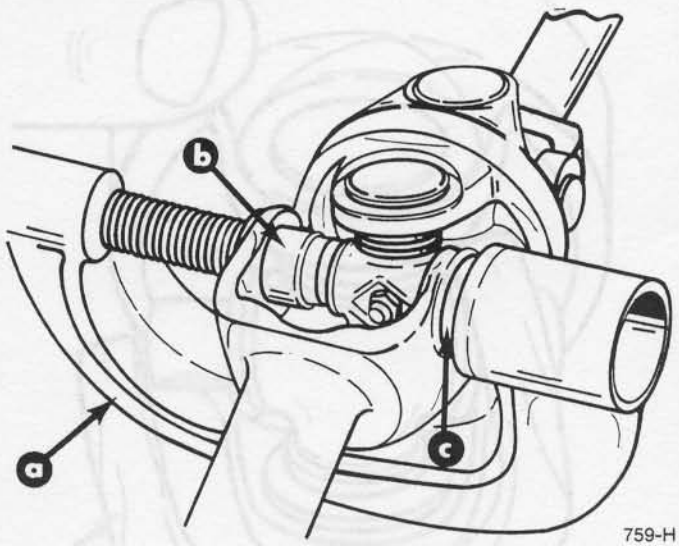
IMPORTANT: If cross and bearings are to be reused, liberally lubricate crosses with 2-4-C Multi-Lube to retain needle bearings during disassembly.

1. Remove C-rings.



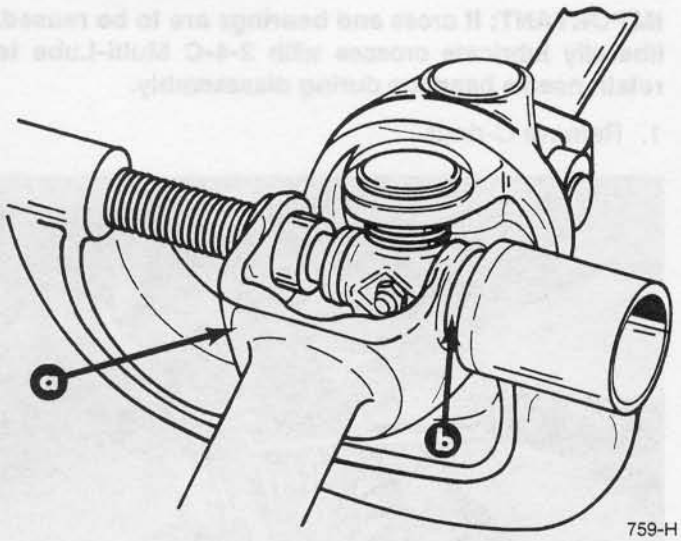
a - C-Ring (4 Per Cross and Bearing)
b - Punch

2. Remove bearing cup.



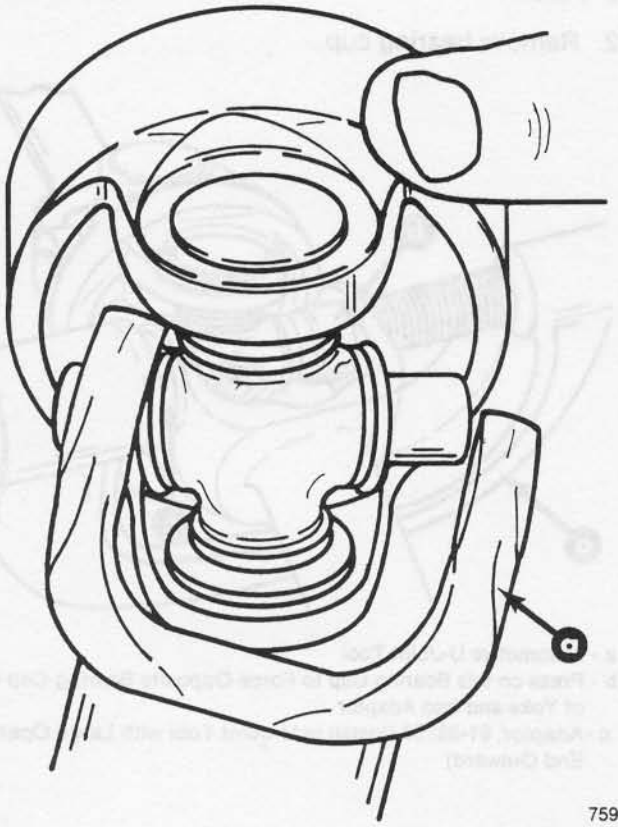
a - Automotive U-Joint Tool
b - Press on this Bearing Cap to Force Opposite Bearing Cap Out of Yoke and into Adaptor
c -Adaptor, 91-38756 (Install in U-Joint Tool with Large Opening End Outward)

3. Remove second bearing.



a - Turn U-Joint Tool 180° and Apply Pressure to End of Cross from Which Bearing Was Removed
b - Press Second Bearing Cap into Adaptor

4. Remove yoke.



a - Yoke

Inspection - After Disassembly

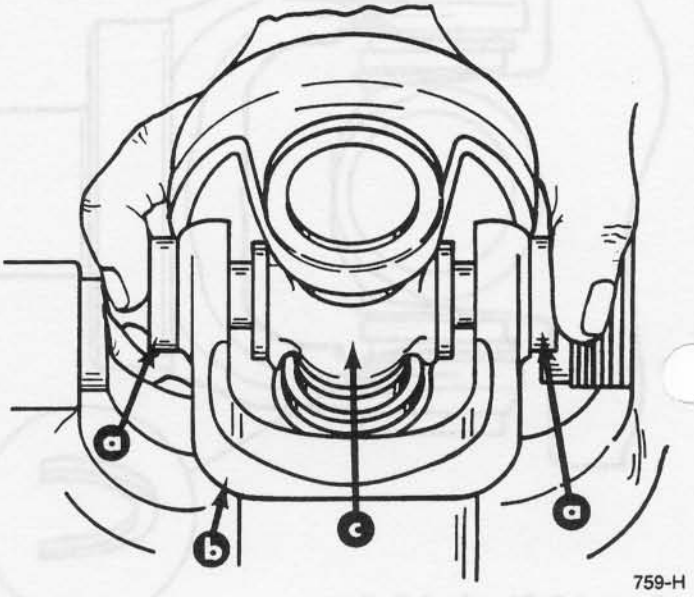
IMPORTANT: DO NOT clean bearing with solvent, as this will wash away the lubricant that retains needle bearing.

1. Inspect crosses for the following:
   a. Inspect bearing surfaces for pitting, scratches and grooves.
   b. Inspect ends for galling.
   c. Inpsect seal for cracks or other signs of deterioration.

Reassembly

IMPORTANT: Use only 2-4-C Multi-Lube for lubricating U-joint.

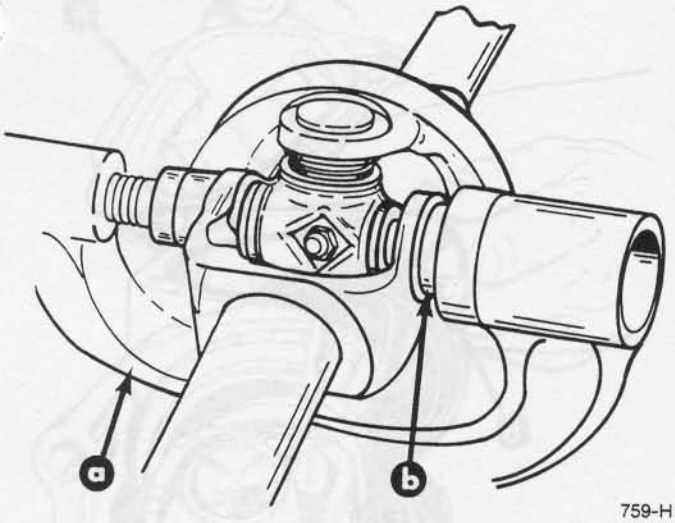
1. Position components as shown.



a - Bearing Caps
b - Yoke
c - Cross

IMPORTANT: Crosses MUST BE installed so that grease fittings are toward coupling end yoke.

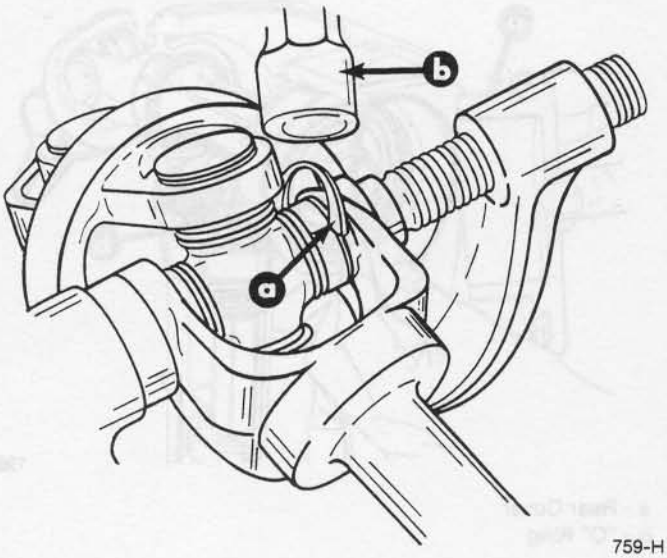
2. Press bearing caps into yoke and onto cross.



759-H

a - Automotive U-Joint Tool
b - Adaptor, 91-38756 (Install in U-Joint Tool with Small Opening End Outward)

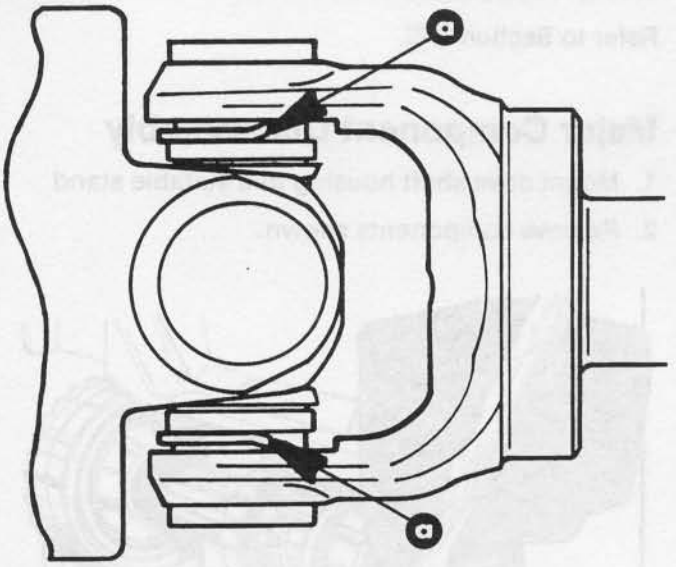
3. Install C-Rings.



759-H

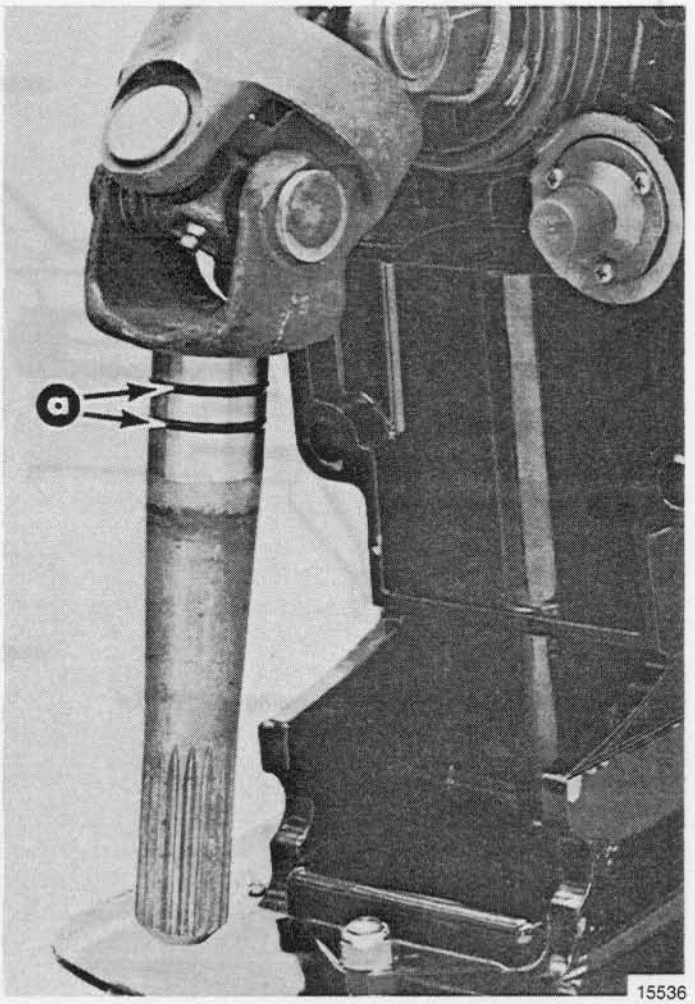
a - C-Rings (4 Per Cross)
b - Hammer

IMPORTANT: If unit is equipped with curved C-rings, install rings with curved in side toward yoke or outer socket.



a - Curved In Side

4. Repeat same procedure for other bearing caps.
5. Lubricate cross and bearings with a liberal amount of 2-4-C Multi-Lube.
6. If applicable, install new "O" rings on yoke.



15536

a - "O" Rings

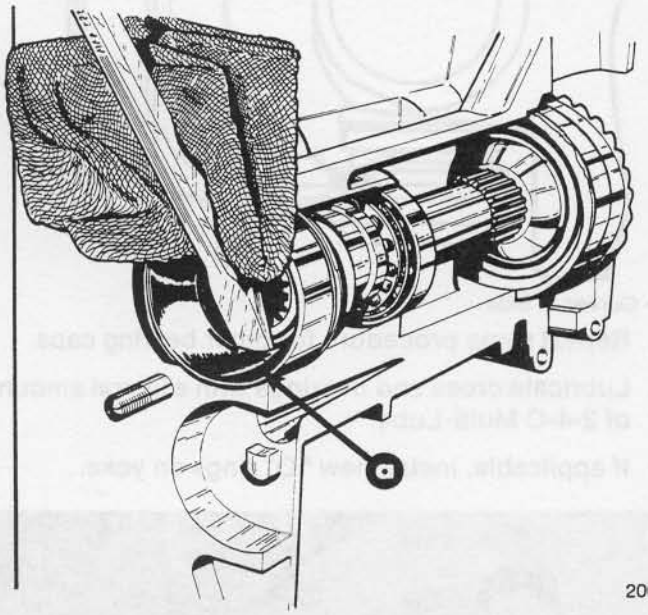
Borg Warner Transmission Type U-Joint Yoke

Drive Shaft Housing Removal and Installation

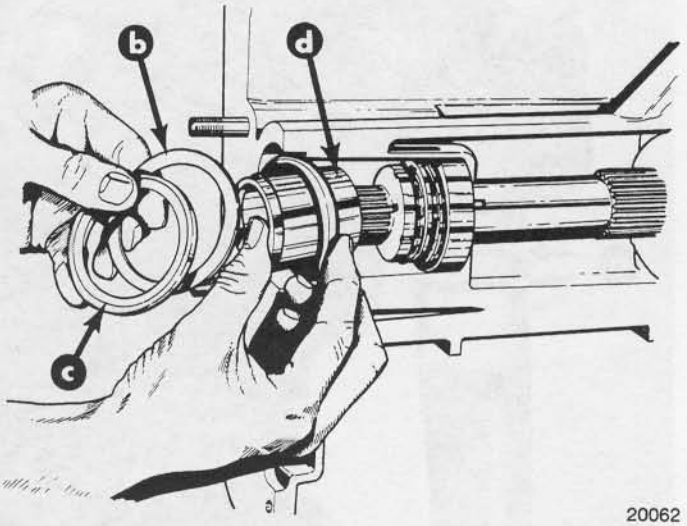
Refer to Section 3-C.

Major Component Disassembly

1. Mount drive shaft housing in a suitable stand.
2. Remove components shown.



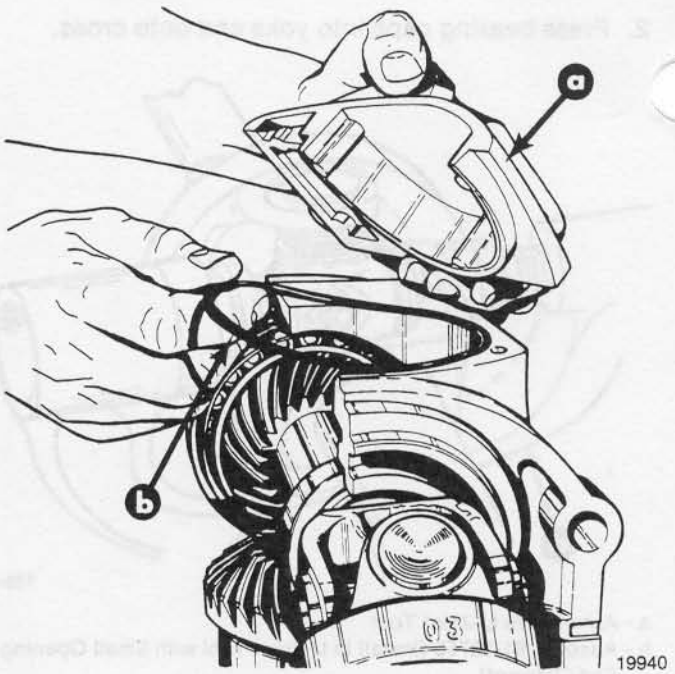
20056



20062

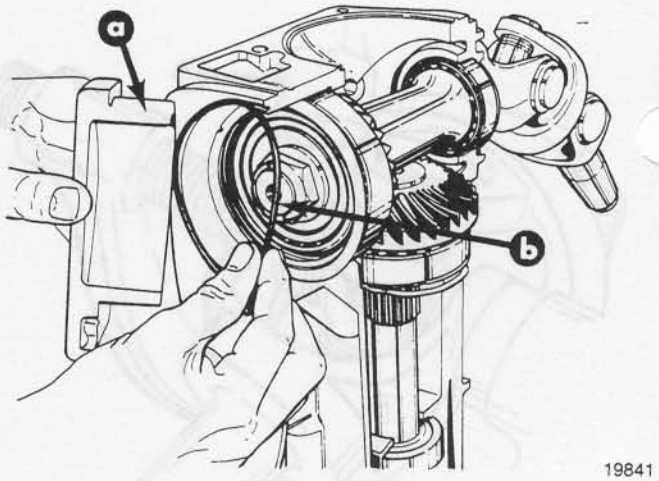
a - Bearing Cup - Pad Drive Shaft Housing and Pry Out
b - Spacer
c - Shim(s)
d - Coupling

3. Remove covers.



19940

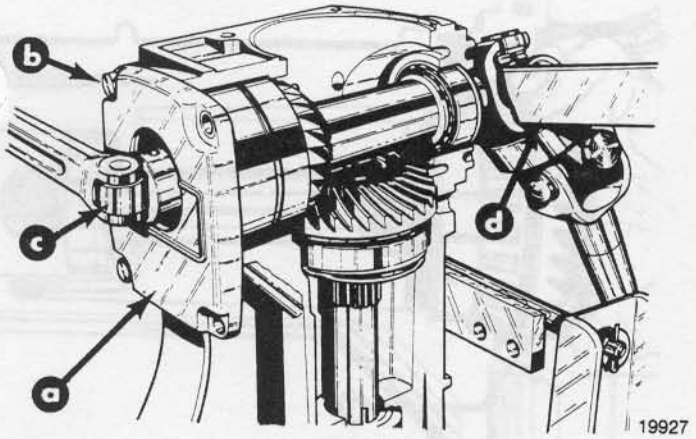
a - Top Cover
b - "O" Ring



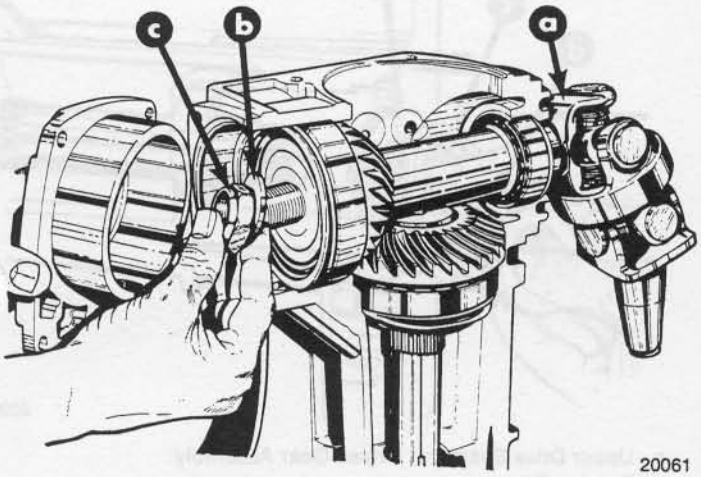
19841

a - Rear Cover
b - "O" Ring

4. Remove U-joint shaft nut and U-joint assembly.

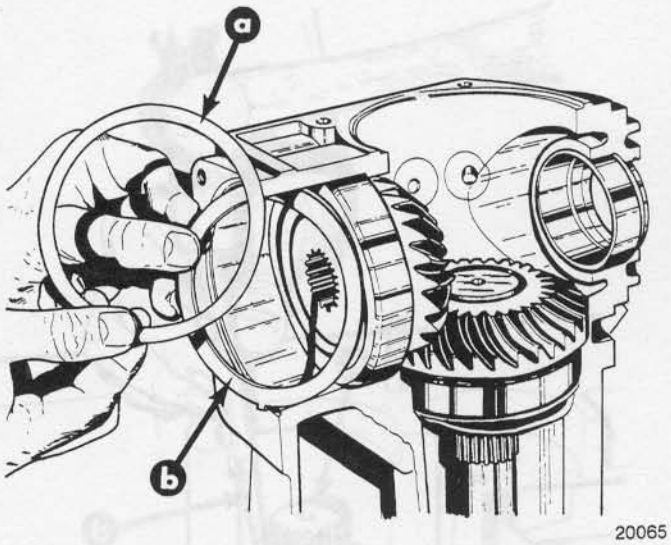


a - Bearing Holder, 91-63625
b - Screws (4), Rear Cover Attaching
c - Breaker Bar and Socket
d - Bar

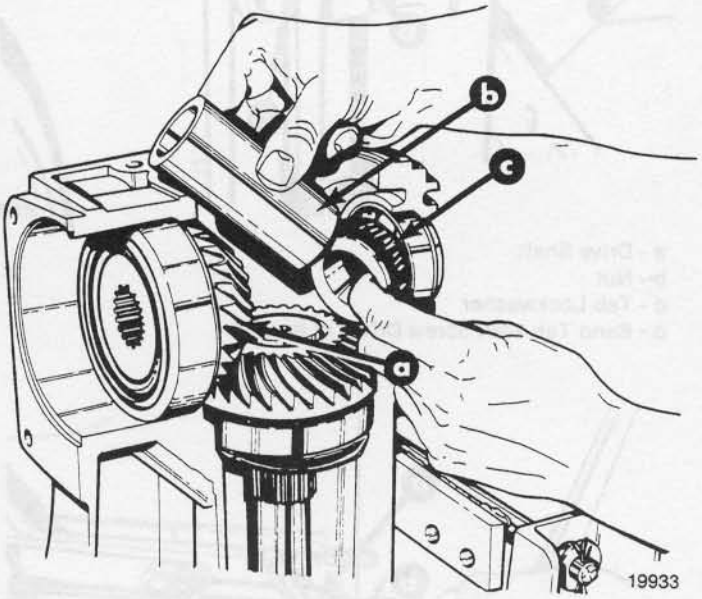


a - U-Joint Assembly
b - Washer
c - Nut

5. Remove drive gear and related parts.

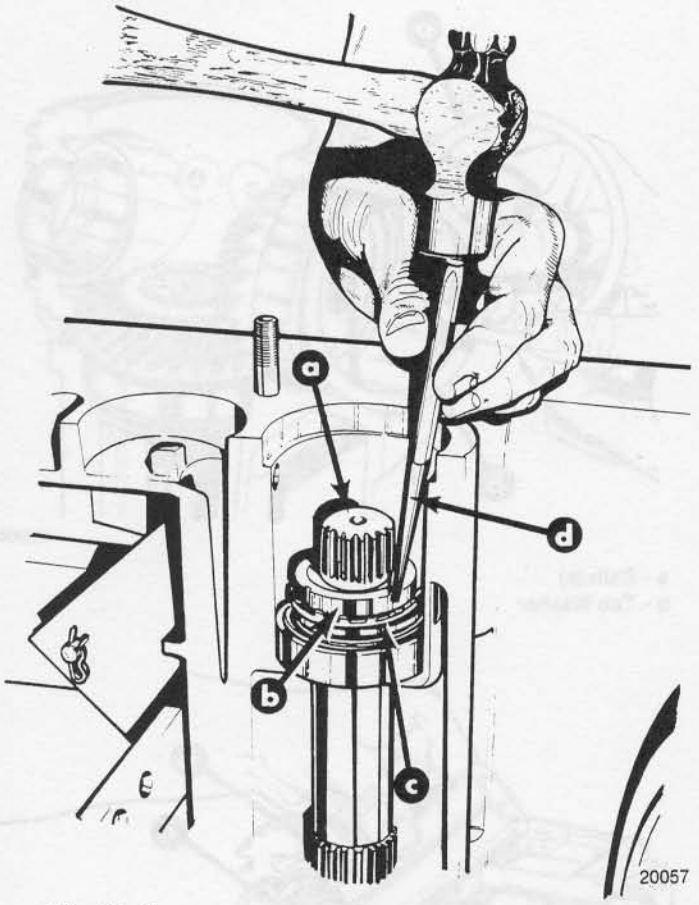


a - Shim(s)
b - Tab Washer

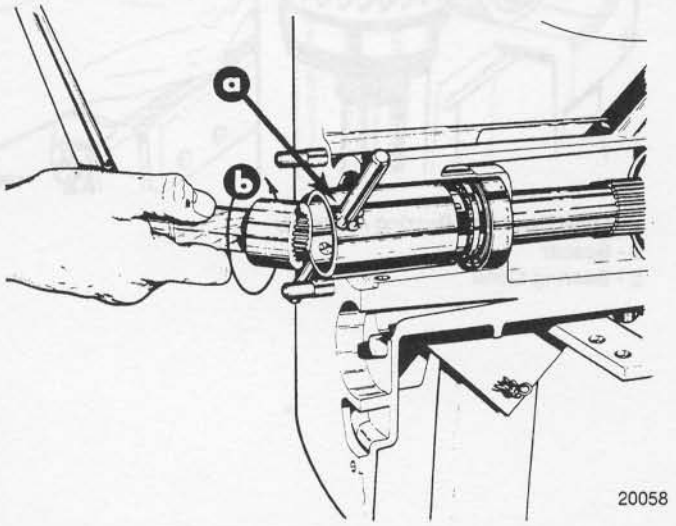


a - Drive Gear and Bearing Assembly
b - Spacer
c - Bearing Cone

6. Remove upper drive shaft nut.

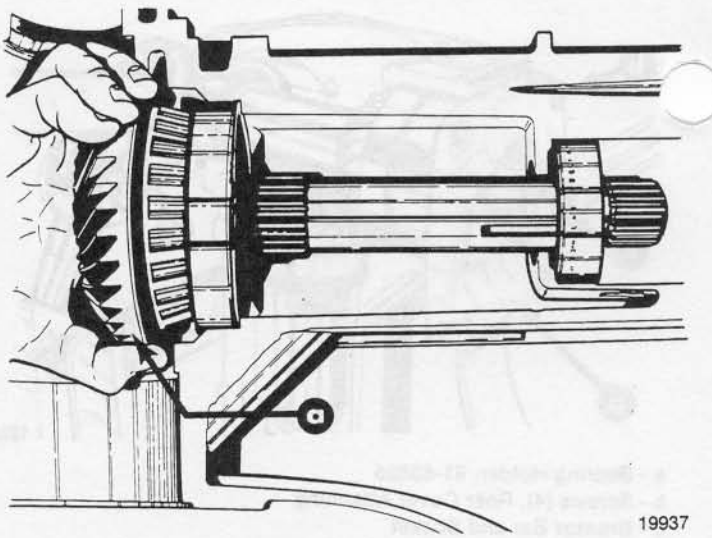


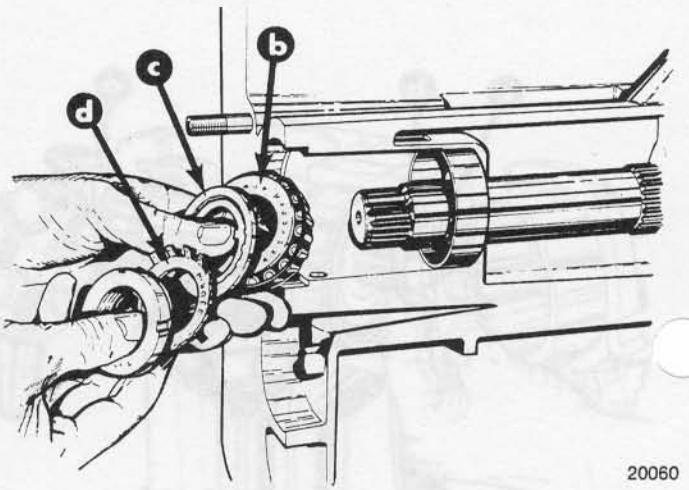
a - Drive Shaft
b - Nut
c - Tab Lockwasher
d - Bend Tab With Screw Driver or Punch



a - Bearing Nut Wrench and Drive Shaft Socket 91-63620A1
b - Turn Socket In This Direction

7. Remove upper drive shaft and related parts.





a - Upper Drive Shaft and Driven Gear Assembly
b - Bearing Cone
c - Flat Tab Washer
d - Tab Lockwasher

NOTE: Drive shaft housing components can be inspected with housing disassembled to this point. DO NOT remove drive and driven gear bearing inner race unless replacement is necessary.

Subassembly Cleaning and Inspection

Refer to "Basic Cleaning and Inspection" (Sec. 1). Important points of attention are outlined following.

U-Joint Assembly

Refer to information outlined under "U-Joint Coupling End Yoke and Cross and Bearing Assembly Servicing", preceding.

Oil Passage Connector

Inspect for corrosion damage that could prevent it from sealing properly.

Subassembly Servicing

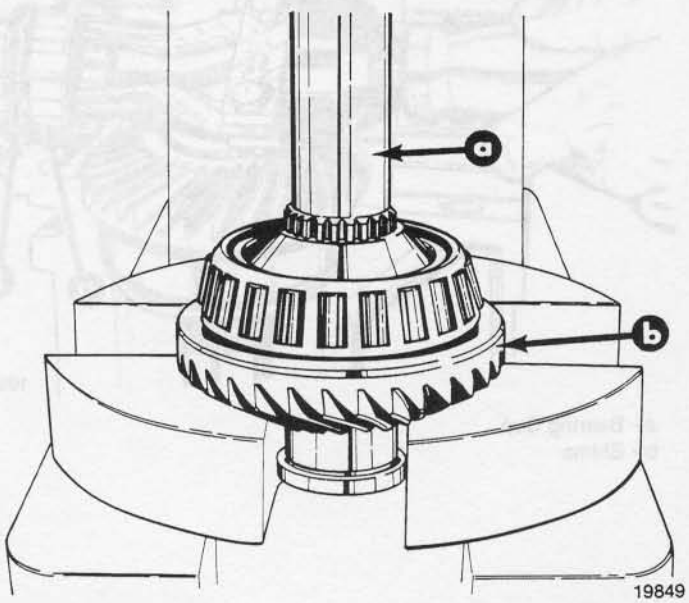
U-Joint Assembly

Refer to "U-Joint Coupling End Yoke and Cross and Bearing Assembly Servicing", preceding.

Upper Drive Shaft/Driven Gear/Drive Gear

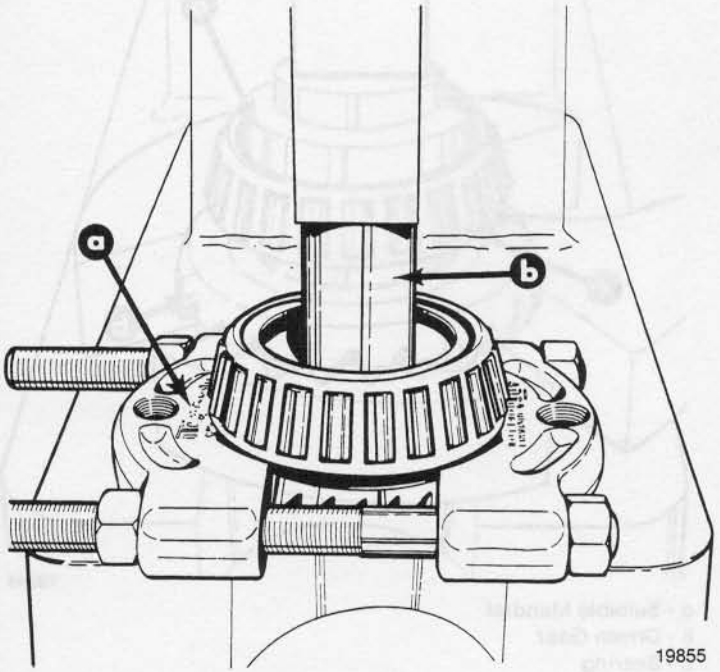
DISASSEMBLY

1. Remove drive shaft from driven gear.



a - Upper Drive Shaft
b - Driven Gear

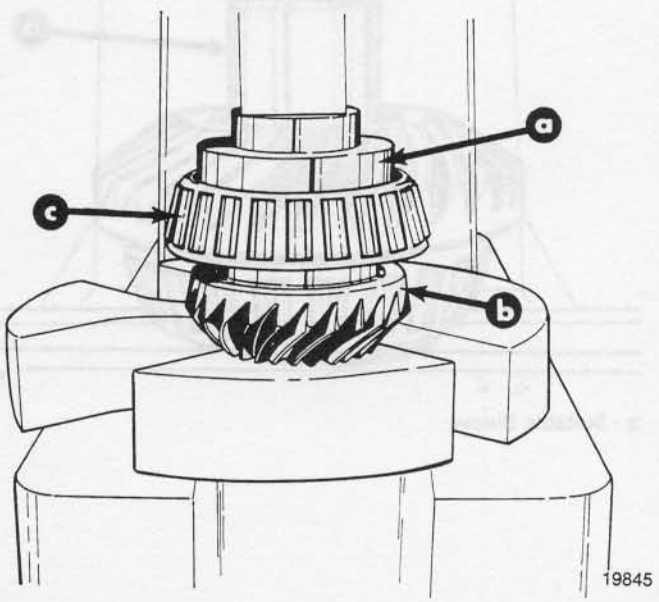
2. Remove bearing from gear.



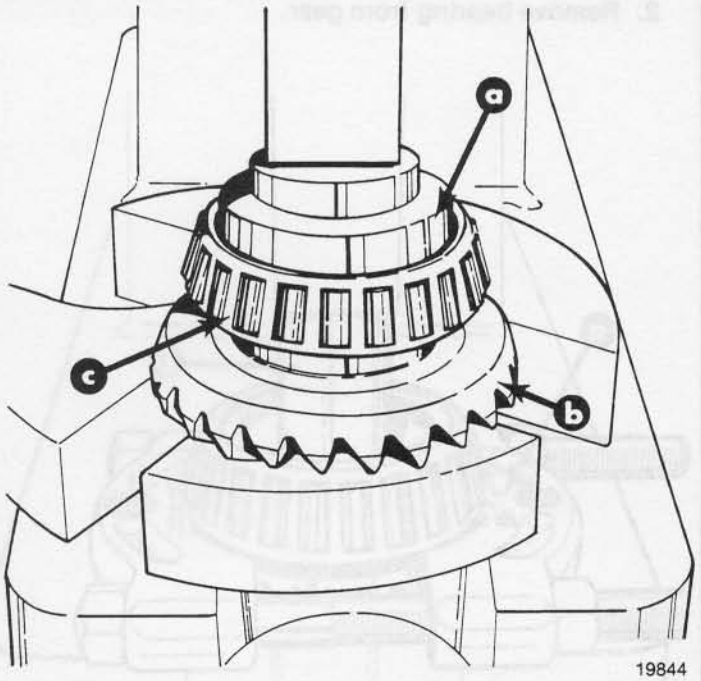
a - Universal Puller Plate, 91-37241
b - Suitable Mandrel

REASSEMBLY

1. Install bearings on gears.



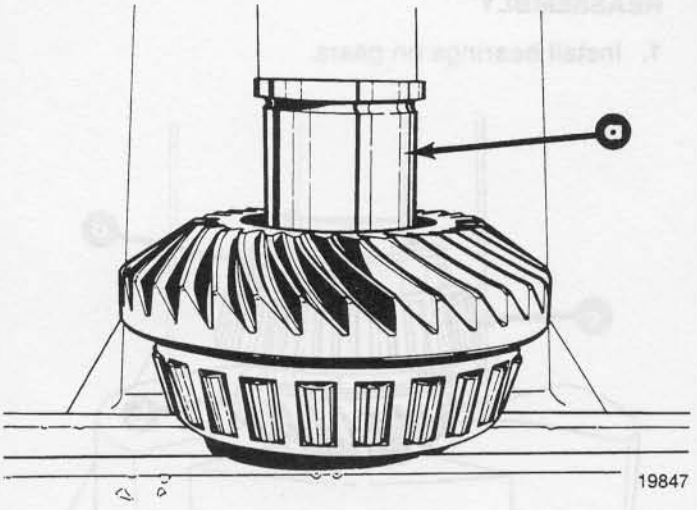
a - Suitable Mandrel
b - Drive Gear
c - Bearing



19844

a - Suitable Mandrel
b - Driven Gear
c - Bearing

2. Install drive shaft to driven gear and bearing assembly.



19847

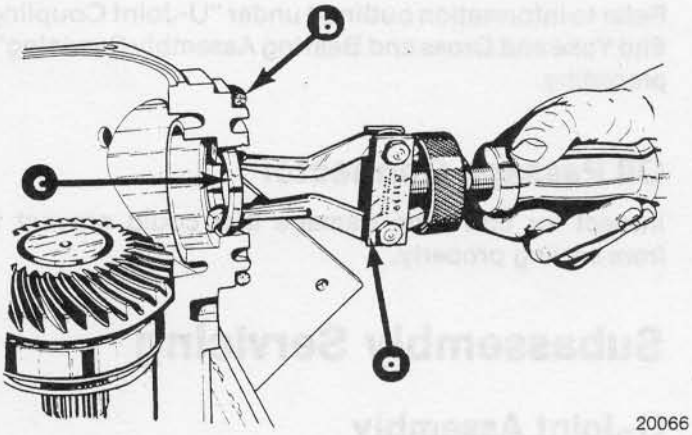
a - Suitable Sleeve

Drive Shaft Housing

DISASSEMBLY

IMPORTANT: Before removing seal, following, measure depth that seal is recessed into housing (for later use).

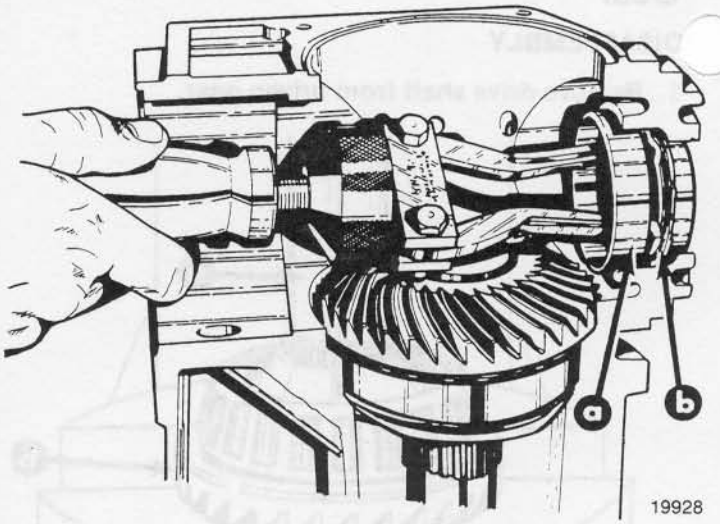
1. Remove U-joint seal and pilot "O" ring.



20066

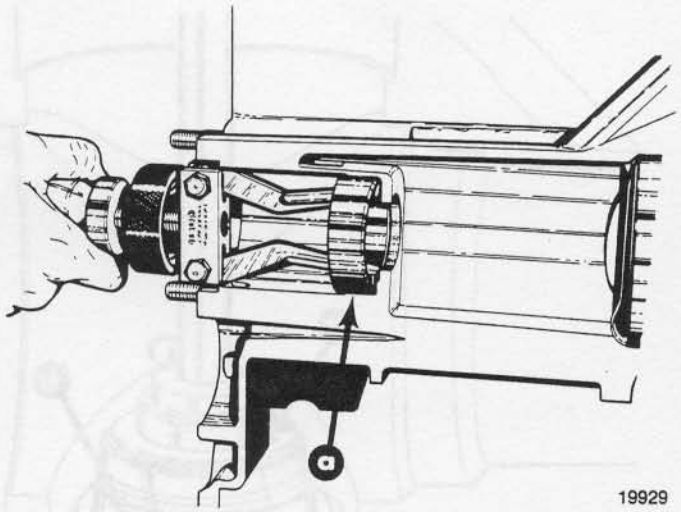
a - Slide Hammer Puller, 91-34569A1
b - Oil Seal
c - "O" Ring

2. Remove outer bearing cups, using Slide Hammer Puller 91-34569A1.

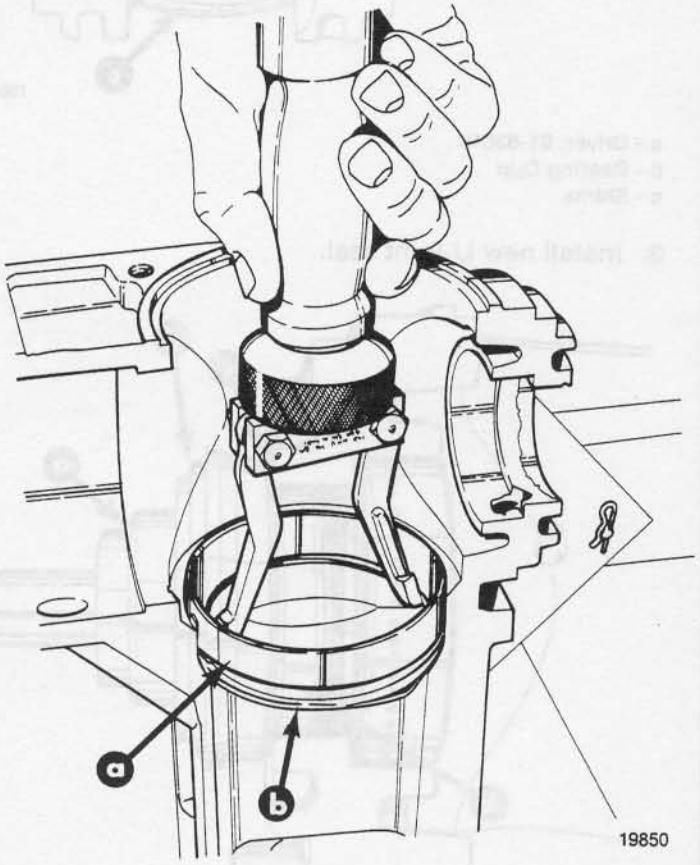


19928

a - Bearing Cup
b - Shims

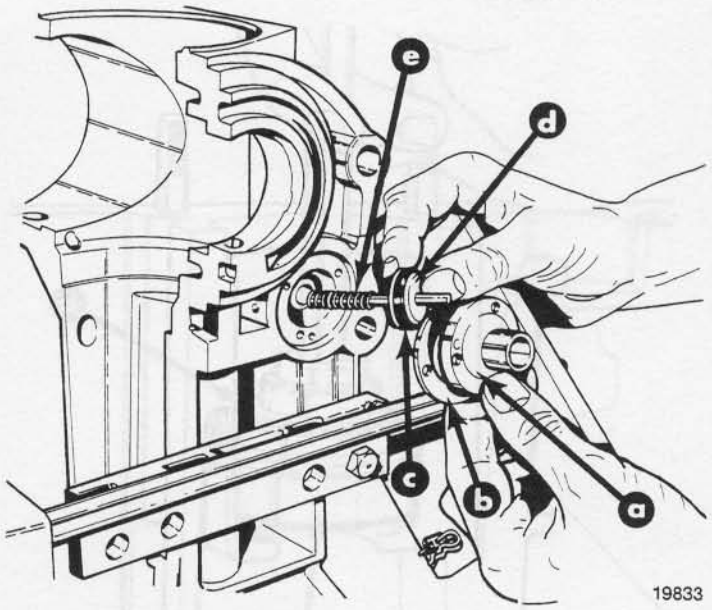


a - Bearing Cup



a - Bearing Cup
b - Shims

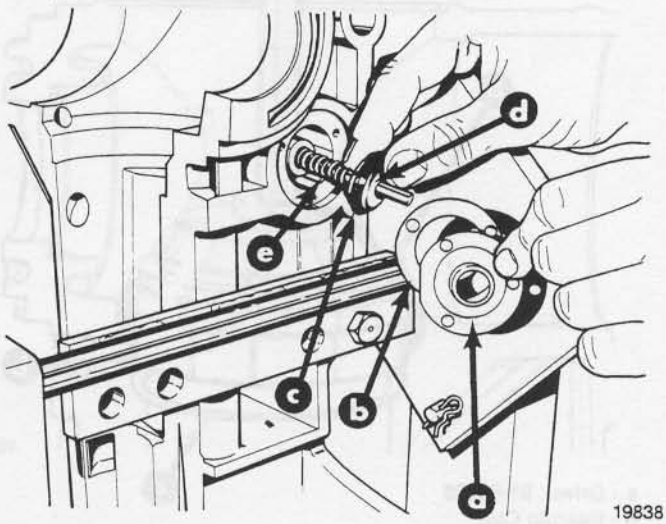
3. If leaking, remove oil passage connector and related parts.



a - Connector
b - Gasket
c - Quad Ring
d - Check Valve
e - Spring

REASSEMBLY

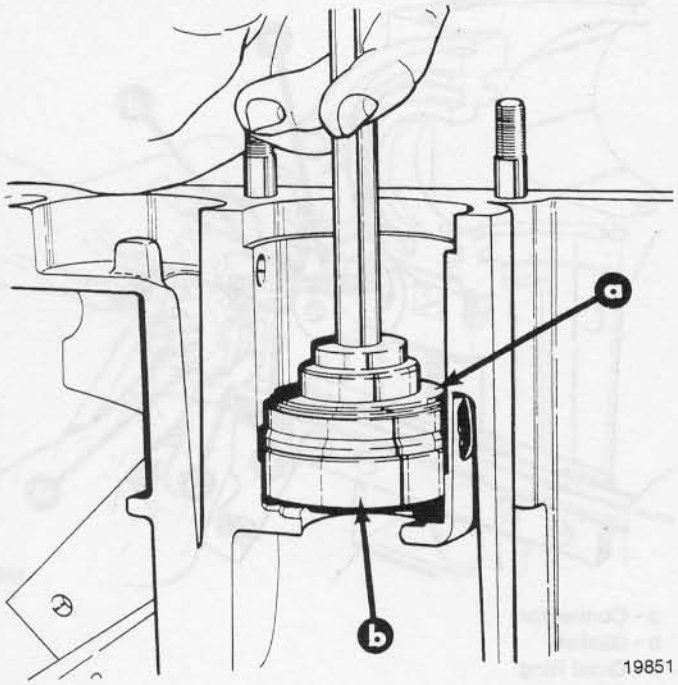
1. Install oil passage connector and related parts. Use new gasket and quad ring. Torque screws to 30 lbs. in. (3.4 N.m)



a - Connector
b - New Gasket
c - New Quad Ring
d - Check Valve
e - Spring

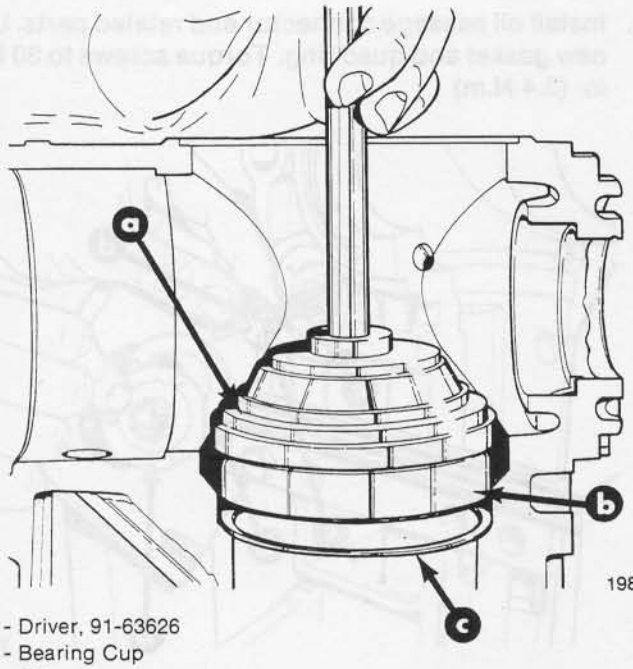
Oil Passage Connector Screw Torque 30 Lbs. In. (3.4 N.m)

2. Install bearing cups with original thickness shims. Refer to "Major Component Reassembly" for shimming procedure.



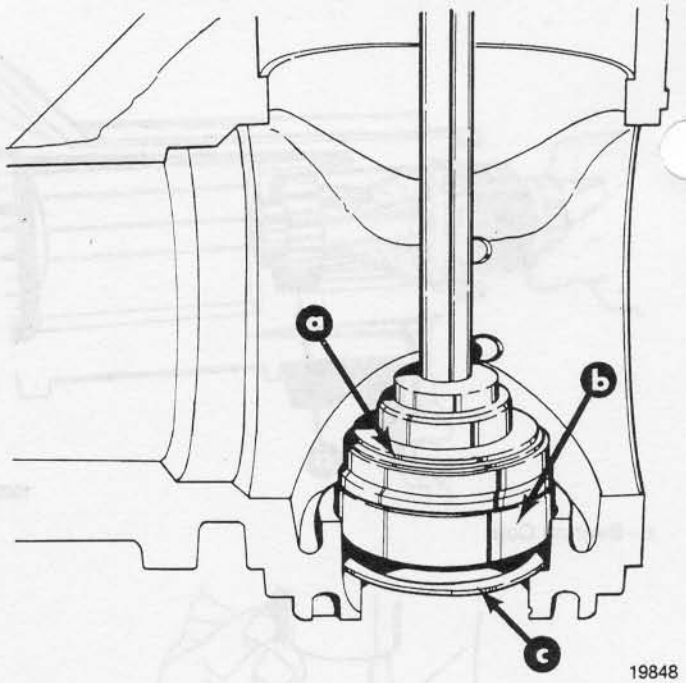
19851

a - Driver, 91-63619 (Use With Chamferred Side Away from Bearing)
b - Bearing Cup



19846

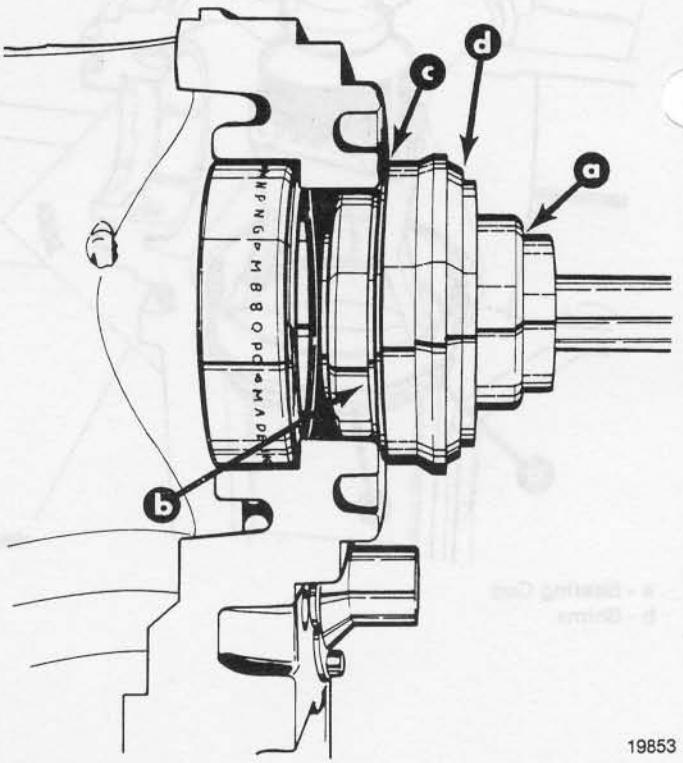
a - Driver, 91-63626
b - Bearing Cup
c - Shims



19848

a - Driver, 91-63619
b - Bearing Cup
c - Shims

3. Install new U-joint seal.

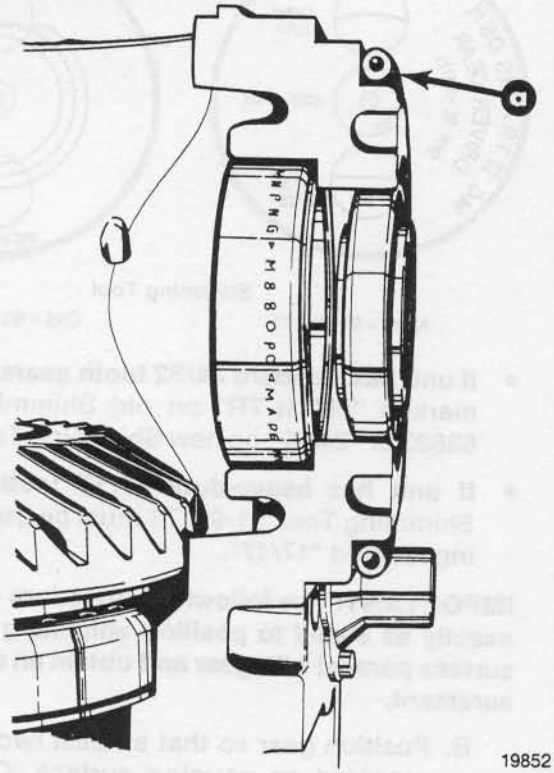


19853

a - Driver, 91-63619
b - Install Seal With Lip Facing Inward. Apply Loctite "A" to Seal Case
c - Use This Side of Tool to Install Seal 1/16 In. (1.6mm) Deep
d - Use This Side of Tool To Install Seal 1/8 In. (3.2mm) Deep

IMPORTANT: If using original U-joint gear end yoke, install seal to a different depth than original seal, using appropriate side of driver. Seal is installed flush with the drive shaft housing from the factory.

4. Install new pilot "O" ring.



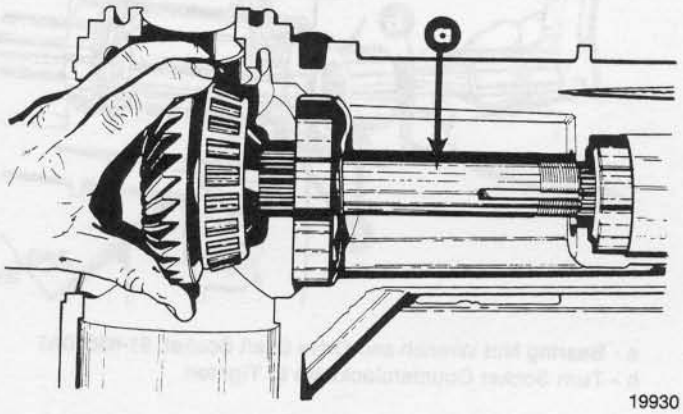
19852

a - Use Bellows Adhesive, or Adhesive, to Retain "O" Ring

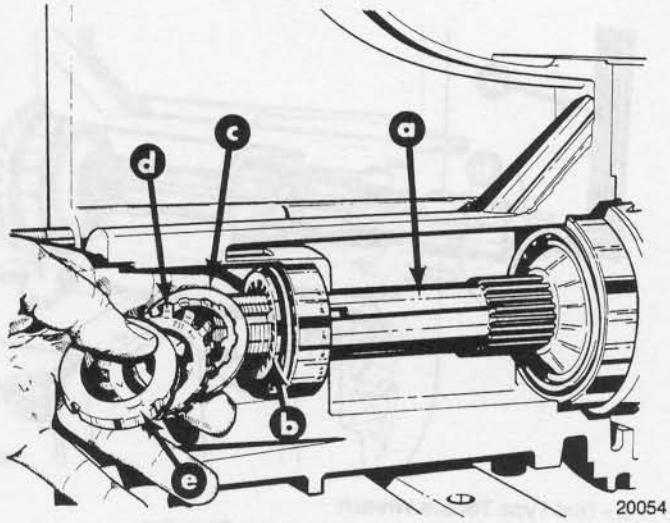
Major Component Reassembly and Shimming

IMPORTANT: Lubricate gears, bearings, seals and "O" rings with Super-Duty Lower Unit Lubricant before installing. Bearings and gears MUST BE lubricated to obtain accurate preload readings, following.

1. Install upper drive shaft and driven gear assembly and related components.



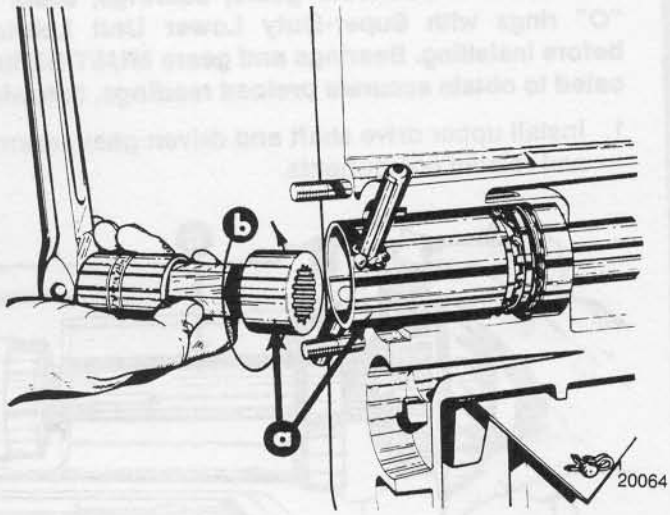
19930



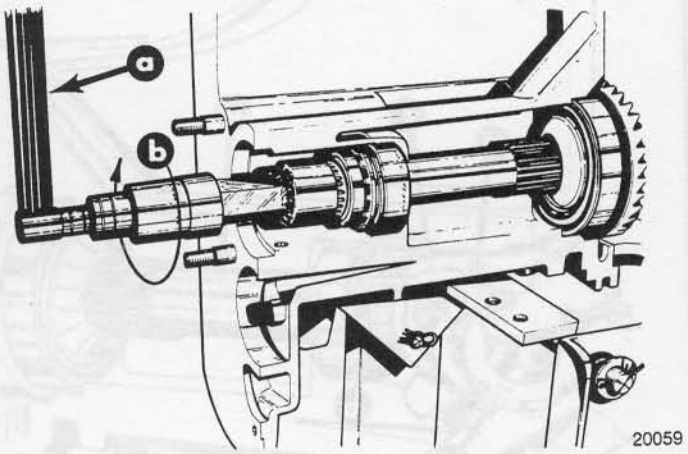
20054

a - Upper Drive Shaft and Driven Gear Assembly
b - Bearing Cone
c - Flat Tab Washer
d - Tab Lockwasher
e - Nut

2. Setting "Upper Drive Shaft Bearing Preload", tighten drive shaft bearing nut to obtain bearing preload shown, following. Slot in nut must align with tab on lockwasher. Record reading for later use.



a - Bearing Nut Wrench and Drive Shaft Socket, 91-63620A1
b - Turn Socket Counterclockwise to Tighten



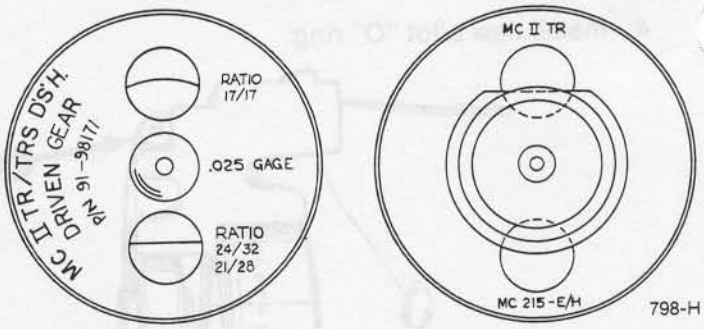
a - Dial Type Torque Wrench
b - Take rolling Torque Reading In this Direction

Bearing Preload	
New Bearings	5-15 Lbs. In.
*Used Bearings	2-6 Lbs. In.

*Bearings are considered used if spun under once.

3. Driven Gear Shimming

A. Insert shimming tool into drive shaft housing with appropriate opening toward gear.



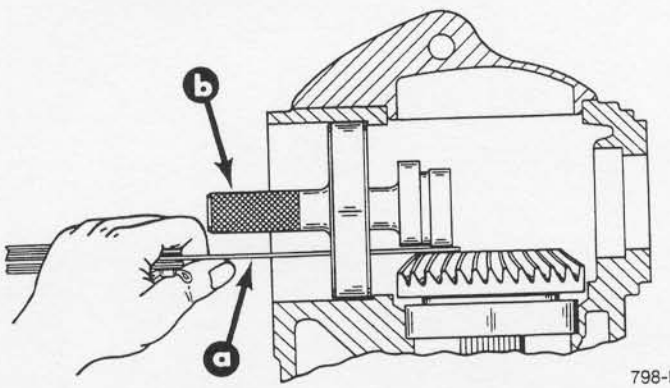
Shimming Tool

New - 91-98171 Old - 91-63623

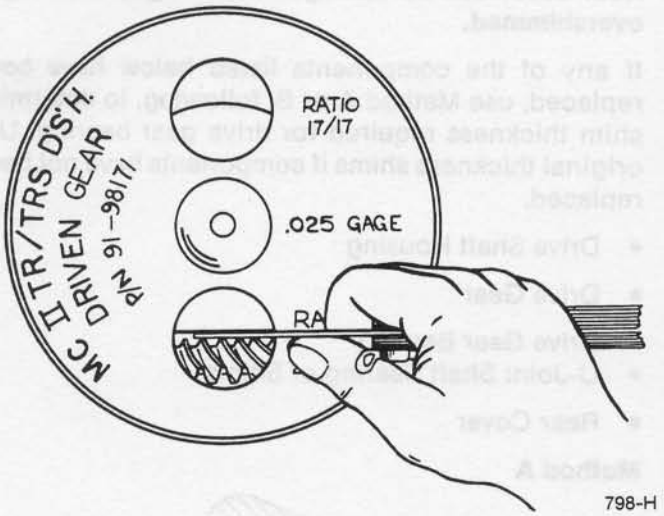
- **If unit has standard 24/32 tooth gears,** use opening marked "MC II-TR" on old Shimming Tool, 91-63623 or "24/32" on new Shimming Tool, 91-98171.
- **If unit has heavy-duty 17/17 tooth gears,** new Shimming Tool, 91-98171 must be used. Use opening marked "17/17".

IMPORTANT: The following procedure must be done exactly as stated to position shimming tool gauging surface parallel with gear and obtain an accurate measurement.

B. Position gear so that at least two full teeth are centered on gauging surface. One full tooth must be on each side of gauging surface centerline. Insert a .025 in. (.635mm) feeler gauge between one of the teeth and gauging surface. Rotate shimming tool until gauging surface contacts feeler gauge and a slight drag on feeler gauge is felt.



C. Without moving shimming tool, remove feeler gauge and insert gauge between other tooth and gauging surface.



798-H

- **If feeler gauge can be inserted with only a slight drag,** shimming is corect. Proceed to Step 3.
- **If feel gauge inserts with no drag, gear is too low.** Repeat Step 2-B and 2-C with progressively thicker feeler gauges until the same clearance is obtained between both gear teeth and gauging surface. Calculate the thickness shims to add under driven gear bearing cup, as shown following.

Clearance Between Gear Tooth and Shimming Tool −.025 in.= Additional Thickness Shims Required

Example:

.028 in. - .025 in. = .003 in.

Shims equal to this thickness must be added under driven gear bearing cup.

- **If feeler gauge cannot be inserted without moving shimming tool,** gear is too high. Repeat Step 2-B and 2-C with progressively thinner feeler gauges until the same clearance is obtained between both gear teeth and gauging surface. Calculate thickness shims to remove from under driven gear bearing cup, as shown following.

.025 in. − Clearance Between Gear Teeth and Shimming Tool = Reduction In Shim Thickness Required

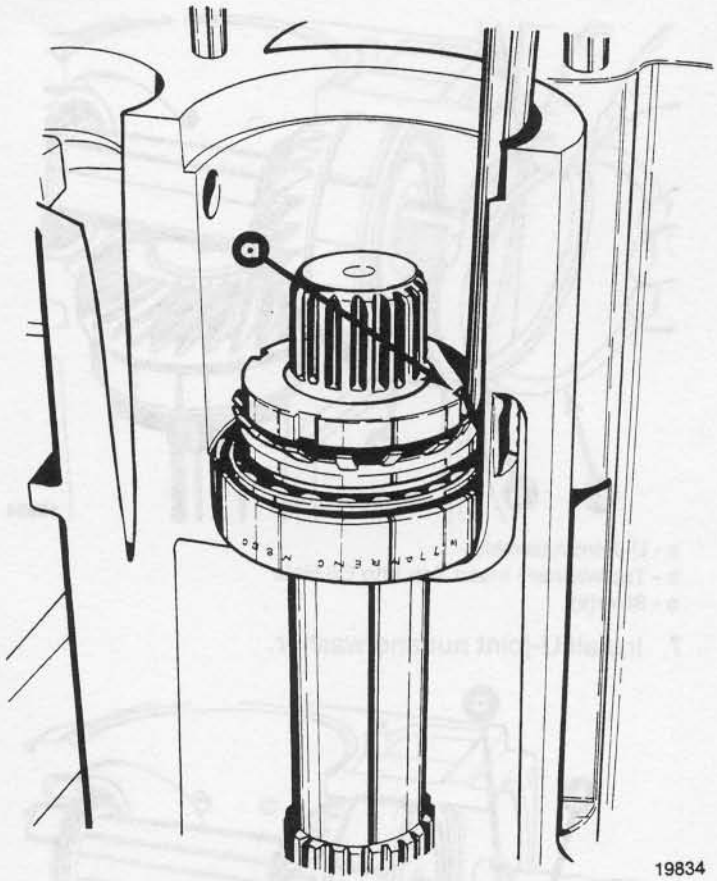
.025 in. - .021 in. = .004 in.

Shims equal to this thickness must be removed from under driven gear bearing cup.

D. Add or subtract shims from under driven gear bearing cup, as required.

E. Readjust bearing preload (Step 2) and recheck shimming.

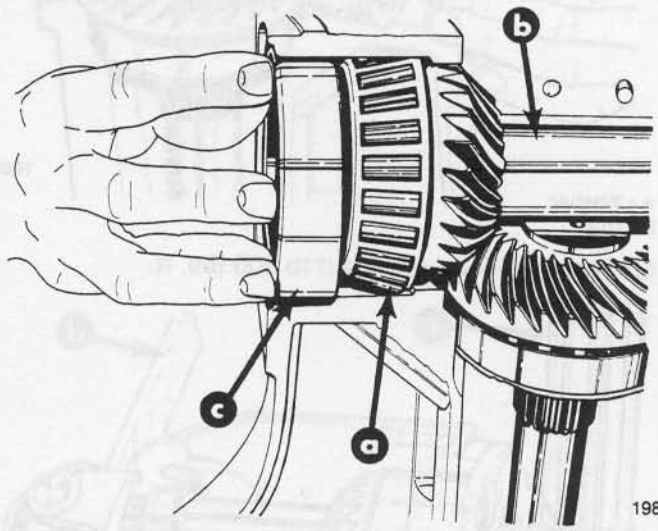
4. Bend tab on tab washer to secure bearing nut.



19834

a - Bend Tab On Lockwasher Into Slot In Nut

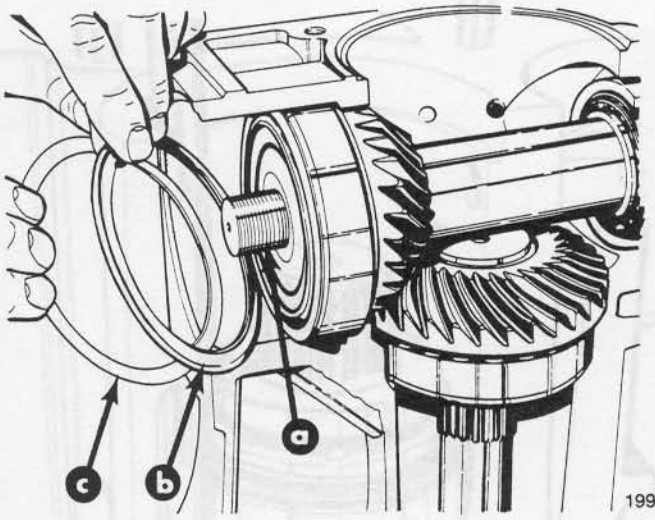
5. Install items shown.



19840

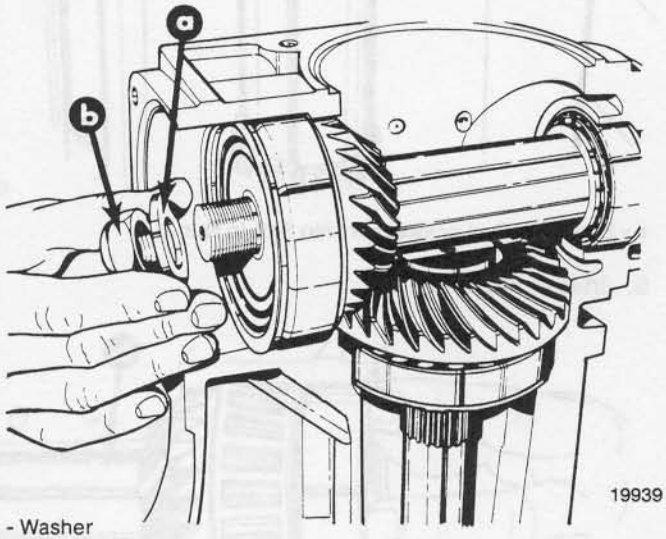
a - Drive Gear and Bearing Assembly
b - Spacer
c - Bearing Cup

6. Install U-joint assembly, tab washer and shims



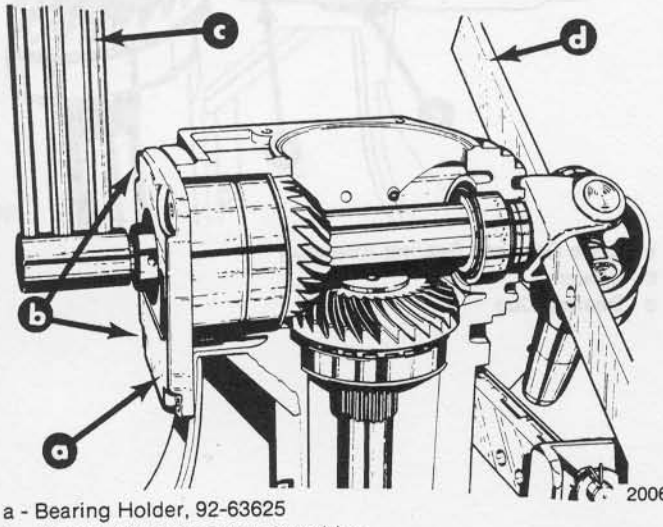
a - U-Joint Assembly
b - Tab Washer - Insert Tab Into Oil Hole
c - Shim(s)

7. Install U-joint nut and washer.



a - Washer
b - Nut

8. Torque U-joint shaft nut to 200 lbs. ft.



a - Bearing Holder, 92-63625
b - Screws (4), Rear Cover Attaching
c - Torque Wrench, 91-32610 and Socket
d - Bar

9. Shimming Drive Gear Bearing.

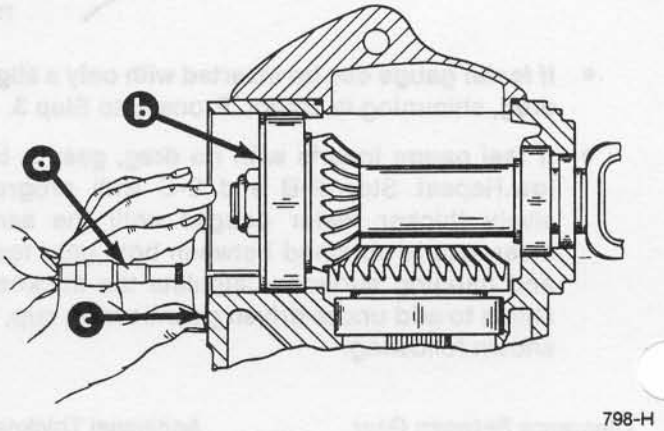
⚠CAUTION

Rear cover can be damaged if drive gear bearing is overshimmed.

If any of the components listed below have been replaced, use Method A or B, following, to determine shim thickness required for drive gear bearing. Use original thickness shims if components have not been replaced.

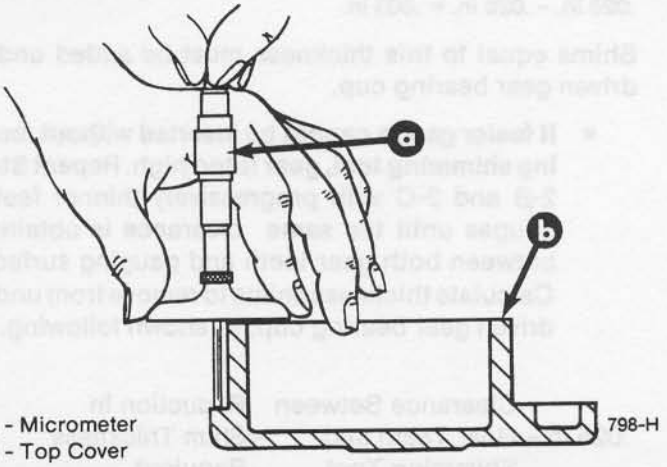
- Drive Shaft Housing
- Drive Gear
- Drive Gear Bearing
- U-Joint Shaft Bearing or Shims
- Rear Cover

Method A



a - 0-1 In. Depth Micrometer
b - Tab Washer
c - Drive Shaft Housing Shoulder

Measurement 1



a - Micrometer
b - Top Cover

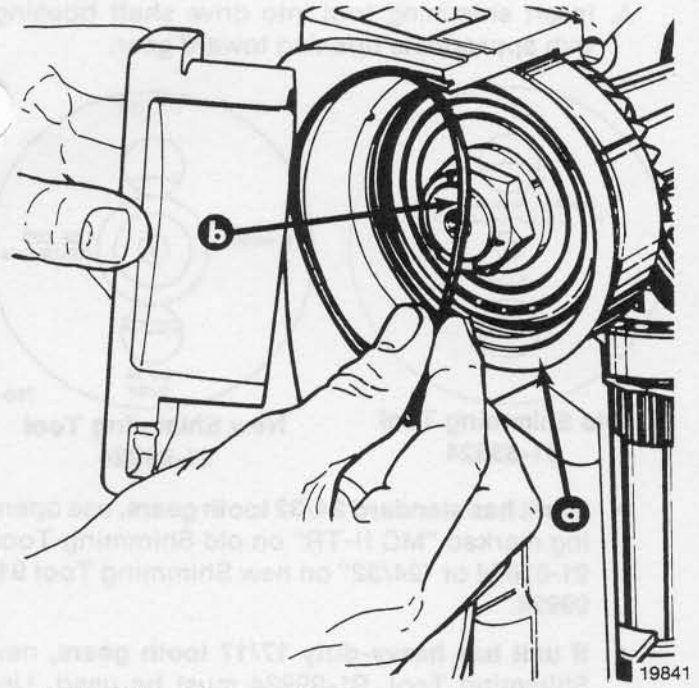
Measurement 2

Measurement 1 - Measurement 2 + .002 in. = Shim Thickness Required

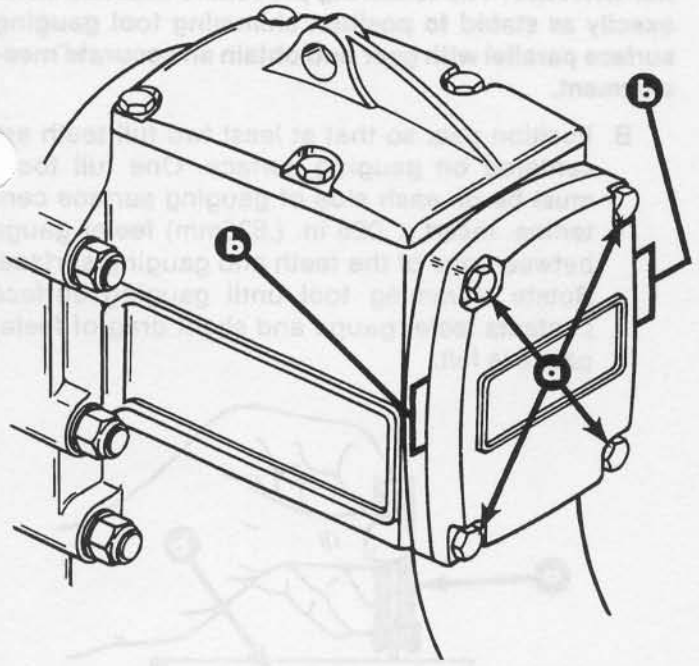
Example:
1.323 in. - 1.303 in. = .020 in. .020 in. + .002 in. .022 in.

Shims equal to this thickness should be used between drive gear bearing cup and rear cover for initial preload check.

Method B



a - .060 In. Shims (Remove After Taking Measurement)
b - Do Not Use "O" Ring



a - Tighten Nuts Evenly Until Snug
b - Measure Clearance (Using Feeler Gauge) Between Cover and Housing At 2 Locations. Use Highest Measurement

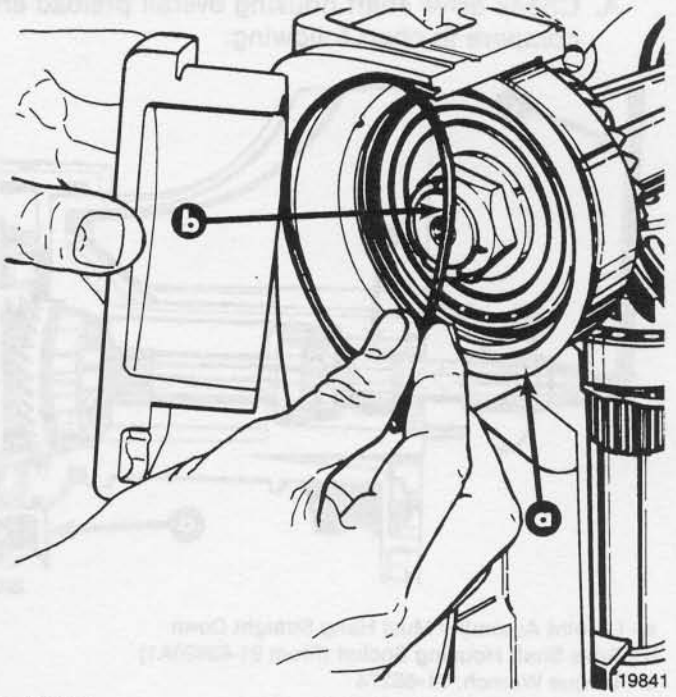
$$.060 \text{ in.} - \text{Clearance Between Cover and Housing} + .002 \text{ in.} = \text{Shim Thickness Required}$$

Example:

.060 in. - .045 in. = .015 in. .015 in. + .002 in. = .017 in.

Shims equal to this thickness should be used between drive gear bearing cup and rear cover for initial preload check.

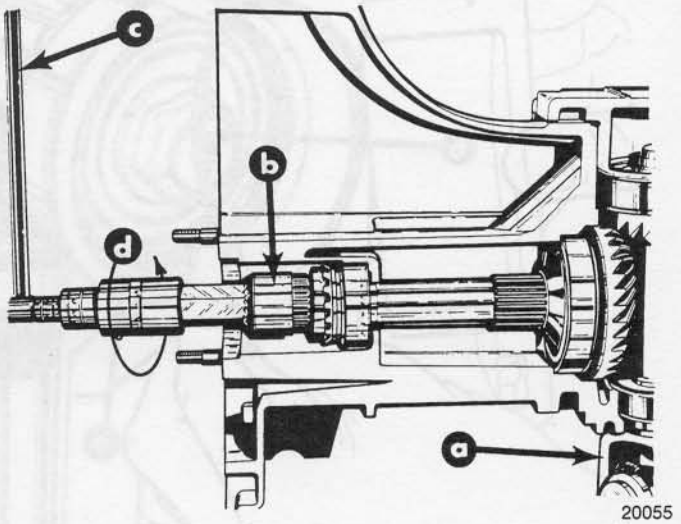
10. Install appropriate thickness shims and rear cover. Torque screws to 20 lbs. ft. (27 N.m)



a - Shims
b - "O" Ring

11. Checking "Drive Shaft Housing Overall Bearing Preload":

A. Check drive shaft housing overall preload and compare to chart following:



20055

a - U-Joint Assembly Must Hang Straight Down
b - Drive Shaft Housing Socket (From 91-63620A1)
c - Torque Wrench, 91-66274
d - Take Reading In This Clockwise Direction

24/32 Tooth Gears	New Bearings	5-11 Lbs. In., Plus Reading from Step 2
	*Used Bearings	2-4 Lbs. In., Plus Reading from Step 2
17/17 Tooth Gears	New Bearings	4-8 Lbs. In., Plus Reading from Step 2
	*Used Bearings	2-3 Lbs. In., Plus Readings from Step 2

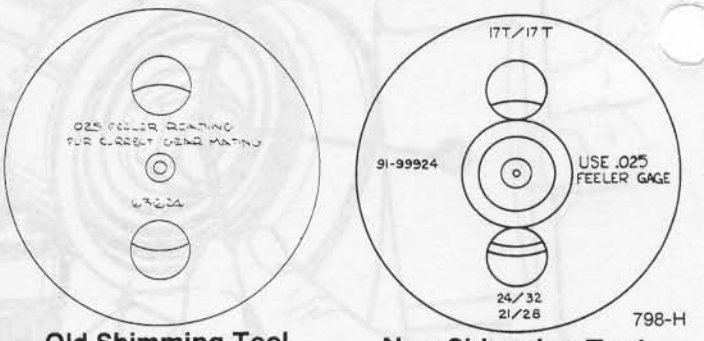
*Bearing is considered used if spun under load once.

- **If preload is too high,** remove shims from between drive gear bearing cup and rear cover until proper reading is obtained.
- **If preload is too low,** add shims (.001 in. at a time) between drive gear bearing cup and rear cover until proper reading is obtained.

B. Record preload reading for later use.

12. Drive Gear Shimming.

A. Insert shimming tool into drive shaft housing with appropriate opening toward gear.



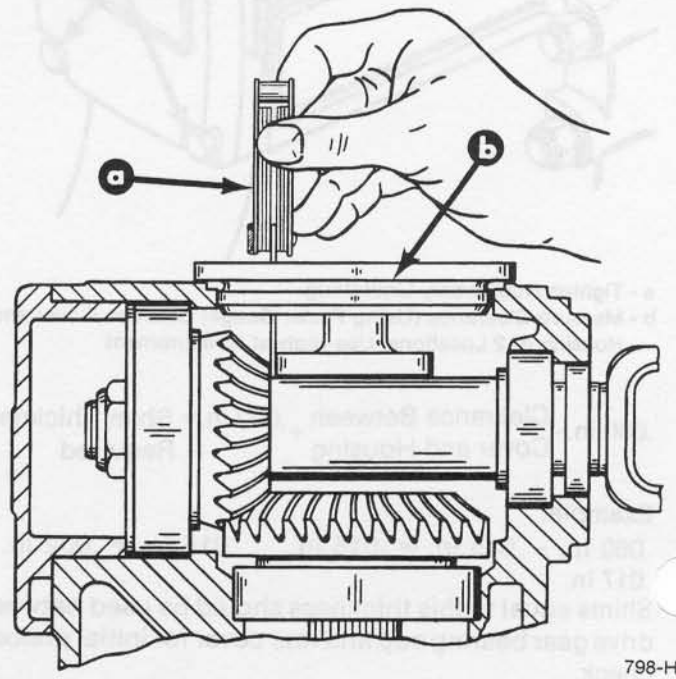
Old Shimming Tool 91-63624

New Shimming Tool 91-99924

- **If unit has standard 24/32 tooth gears,** use opening marked "MC II-TR" on old Shimming Tool, 91-63624 or "24/32" on new Shimming Tool 91-99924.
- **If unit has heavy-duty 17/17 tooth gears,** new Shimming Tool, 91-99924 must be used. Use opening marked "17/17".

IMPORTANT: The following procedure must be done exactly as stated to position shimming tool gauging surface parallel with gear and obtain an accurate measurement.

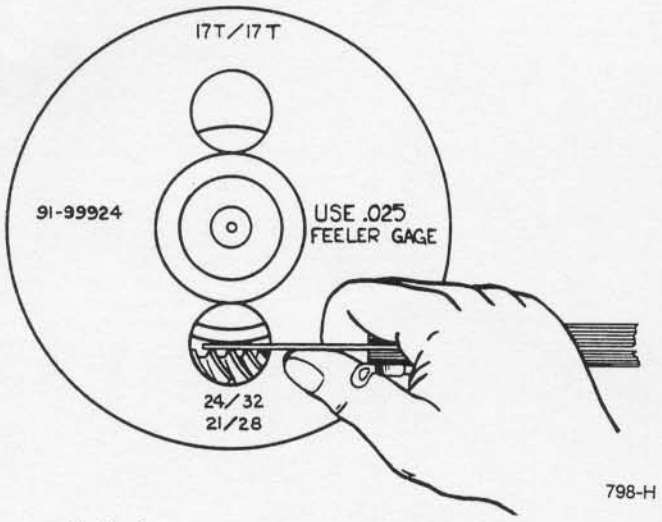
B. Position gear so that at least two full teeth are centered on gauging surface. One full tooth must be on each side of gauging surface centerline. Insert a .025 in. (.635mm) feeler gauge between one of the teeth and gauging surface. Rotate shimming tool until gauging surface contacts feeler gauge and slight drag of feeler gauge is felt.



798-H

a - .025 In. (.635mm) Feeler Gauge
b - Rotate Tool Until a Slight Drag Is Felt On Feeler Gauge

C. Without moving shimming tool, remove feeler gauge and insert gauge between other tooth and gauging surface.



- **If feeler gauge can be inserted with only a slight drag,** shimming is correct. Proceed to Step 13.
- **If feeler gauge inserts with no drag, gear is too far aft.** Repeat Step 12-B and 12-C with progressively thicker feeler gauges until the same clearance is obtained between both gear teeth and gauging surface. Calculate shim thickness to add to drive gear bearing cup and remove from U-joint shaft front bearing cup, as shown following.

Clearance Between Gear Teeth and Shimming Tool	-.025 in.=Shimming Thickness Change Required

Example .030 in. - .025 in. = .005 in.

Shims equal to this thickness must be removed from U-joint shaft forward bearing and added to drive gear bearing.

- **If feeler gauge cannot be inserted without moving shimming tool,** gear is too far forward. Repeat Step 12-B and 12-C with progressively thinner feeler gauges until same clearance is obtained between both gear teeth and gauging surface. Calculate thickness shims to read to U-joint shaft front bearing cup and remove from drive gear bearing cup as shown following.

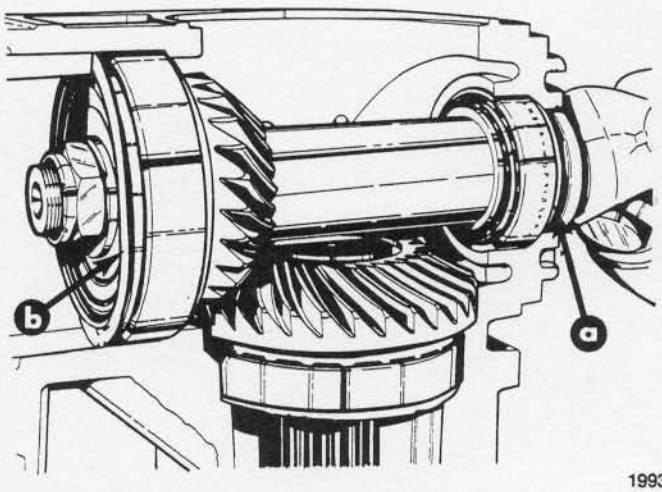
.025 in.	Clearance Between -Gear Teeth and Shimming Tool	Shimming Thickness =Change Required

Example:

.025 in. - .023 in. = .002 in.

Shims equal to this thickness must be added to U-joint shaft joint bearing cup and removed from drive gear bearing cup.

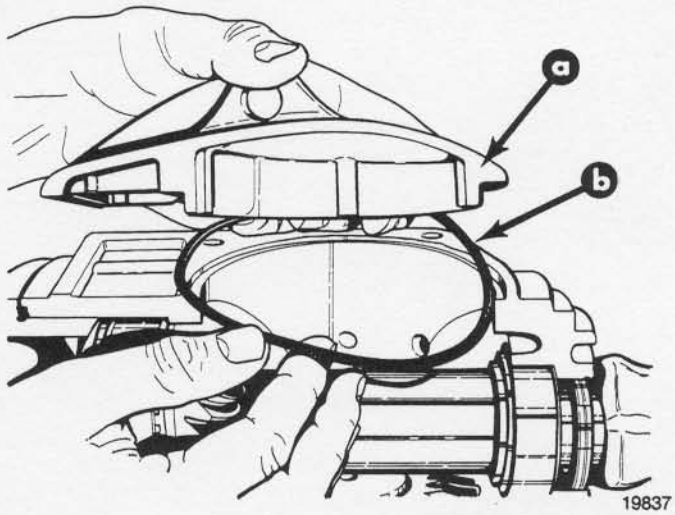
D. Add and subract required amount of shims from locations shown. Recheck shimming and drive shaft housing overall bearing preload after changing shims.



a - Shims, U-Joint Shaft Front Bearing Cup
b - Shims, Drive Gear Bearing Cup

NOTE: Driver, 91-63619 is chamfered, to allow installation of U-joint shaft front bearing cup with driven gear in place.

13. Install top cover and related parts. Torque screws to 20 lbs. ft. (27 N.m).



a - Top Cover
b - "O" Ring

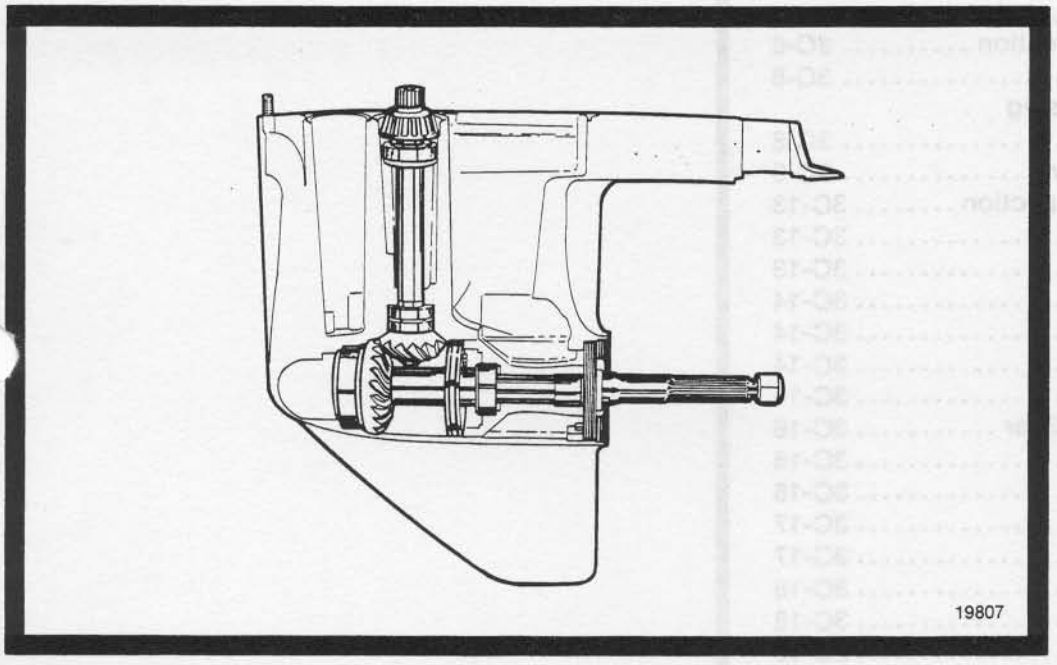
Top Cover Attaching Screw Torque - 20 Lbs. Ft. (27 N.m)

14. Install remainder of components and assemble drive shaft housing to gear housing, as outlined in Section 3-C.

STERN DRIVE UNIT

3

C



GEAR HOUSING

mercruiser
STERN DRIVES & INBOARDS

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Specifications

Torques

Gear Housing to Drive Shaft Housing Nuts	35 lbs. ft. (47 N.m)
Gear Housing to Drive Shaft Housing Screw	50 lbs. ft. (68 N.m)
Pinion Nut (TR & TRS)	150 lbs. ft. (203 N.m)
Propeller Nut (TR & TRS)	55 lbs. ft. (75 N.m) (minimum)

Gear Backlash

Model	Indicator Rod Position	Backlash
TR	"II"	.011 - .015 in. (0.28 - 0.38mm)
TRS	"III"	.009 - .013 in. (0.23 - 0.33mm)

Propeller Shaft Bearing Preload Torques

TR & TRS	New 8-15 lbs. in. Used 3-6 lbs. in.

LOWER DRIVE SHAFT BEARING PRELOAD TR GEAR HOUSING

DRIVE SHAFT HOUSING OVERALL BEARING PRELOAD (LBS. IN.)

PROPELLER SHAFT BEARING PRELOAD (LBS. IN.)

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
3	14-24 11-15	16-26 13-17	17-27 14-18	19-29 16-20	20-30 17-21	22-32 19-23	23-33 20-24	25-35 22-26	26-36 23-27	28-38 25-29	29-39 26-30	31-41 28-32	32-42 29-33	34-44 31-35	35-45 32-36	37-47 34-38	38-48 35-39	40-50 37-41	41-51 38-42	43-53 40-44	44-54 41-45	46-56 43-47	47-57 44-48
4	15-25 12-16	17-27 14-18	18-28 15-19	20-30 17-21	21-31 18-22	23-33 20-24	24-34 21-25	26-36 23-27	27-37 24-28	29-39 26-30	30-40 27-31	32-42 29-33	33-43 30-34	35-45 32-36	36-46 33-37	38-48 35-39	39-49 36-40	41-51 38-42	42-52 39-43	44-54 41-45	45-55 42-46	47-57 44-48	48-58 45-49
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6	17-27 14-18	19-29 16-20	20-30 17-21	22-32 19-23	23-33 20-24	25-35 22-26	26-36 23-27	28-38 25-29	29-39 26-30	31-41 28-32	32-42 29-33	34-44 31-35	35-45 32-36	37-47 34-38	38-48 35-39	40-50 37-41	41-51 38-42	43-53 40-44	44-54 41-45	46-56 43-47	47-57 44-48	49-59 46-50	50-60 47-51
7	18-28 15-19	20-30 17-21	21-31 18-22	23-33 20-24	24-34 21-25	26-36 23-27	27-37 24-28	29-39 26-30	30-40 27-31	32-42 29-33	33-43 30-34	35-45 32-36	36-46 33-37	38-48 35-39	39-49 36-40	41-51 38-42	42-52 39-43	44-54 41-45	45-55 42-46	47-57 44-48	48-58 45-49	50-60 47-51	51-61 48-52
8	19-29 16-20	21-31 18-22	22-32 19-23	24-34 21-25	25-35 22-26	27-37 24-28	28-38 25-29	30-40 27-31	31-41 28-32	33-43 30-34	34-44 31-35	36-46 33-37	37-47 34-38	39-49 36-40	40-50 37-41	42-52 39-43	43-53 40-44	45-55 42-46	46-56 43-47	48-58 45-49	49-59 46-50	51-61 48-52	52-62 49-53
9	20-30 17-21	22-32 19-23	23-33 20-24	25-35 22-26	26-36 23-27	28-38 25-29	29-39 26-30	31-41 28-32	32-42 29-33	34-44 31-35	35-45 32-36	37-47 34-38	38-48 35-39	40-50 37-41	41-51 38-42	43-53 40-44	44-54 41-45	46-56 43-47	47-57 44-48	49-59 46-50	50-60 47-51	52-62 49-53	53-63 50-54
10	21-31 18-22	23-33 20-24	24-34 21-25	26-36 23-27	27-37 24-28	29-39 26-30	30-40 27-31	32-42 29-33	33-43 30-34	35-45 32-36	36-46 33-37	38-48 35-39	39-49 36-40	41-51 38-42	42-52 39-43	44-54 41-45	45-55 42-46	47-57 44-48	48-58 45-49	50-60 47-51	51-61 48-52	53-63 50-54	54-64 51-55
11	22-32 19-23	24-34 21-25	25-35 22-26	27-37 24-28	28-38 25-29	30-40 27-31	31-41 28-32	33-43 30-34	34-44 31-35	36-46 33-37	37-47 34-38	39-49 36-40	40-50 37-41	42-52 39-43	43-53 40-44	45-55 42-46	46-56 43-47	48-58 45-49	49-59 46-50	51-61 48-52	52-62 49-53	54-64 51-55	55-65 52-56
12	23-33 20-24	25-35 22-26	26-36 23-27	28-38 25-29	29-39 26-30	31-41 28-32	32-42 29-33	34-44 31-35	35-45 32-36	37-47 34-38	38-48 35-39	40-50 37-41	41-51 38-42	43-53 40-44	44-54 41-45	46-56 43-47	47-57 44-48	49-59 46-50	50-60 47-51	52-62 49-53	53-63 50-54	55-65 52-56	56-66 53-57
13	24-34 21-25	26-36 23-27	27-37 24-28	29-39 26-30	30-40 27-31	32-42 29-33	33-43 30-34	35-45 32-36	36-46 33-37	38-48 35-39	39-49 36-40	41-51 38-42	42-52 39-43	44-54 41-45	45-55 42-46	47-57 44-48	48-58 45-49	50-60 47-51	51-61 48-52	53-63 50-54	54-64 51-55	56-66 53-57	57-67 54-58
14	25-35 22-26	27-37 24-28	28-38 25-29	30-40 27-31	31-41 28-32	33-43 30-34	34-44 31-35	36-46 33-37	37-47 34-38	39-49 36-40	40-50 37-41	42-52 39-43	43-53 40-44	45-55 42-46	46-56 43-47	48-58 45-49	49-59 46-50	51-61 48-52	52-62 49-53	54-64 51-55	55-65 52-56	57-67 54-58	58-68 55-59
15	26-36 23-27	28-38 25-29	29-39 26-30	31-41 28-32	32-42 29-33	34-44 31-35	35-45 32-36	37-47 34-38	38-48 35-39	40-50 37-41	41-51 38-42	43-53 40-44	44-54 41-45	46-56 43-47	47-57 44-48	49-59 46-50	50-60 47-51	52-62 49-53	53-63 50-54	55-65 52-56	56-66 53-57	58-68 55-59	59-69 56-60

All Values In Chart Are In Lbs. In.

CHART USAGE

1. Measure "Drive Shaft Housing Overall Bearing Preload", as outlined in Section 3-B.
2. Adjust and record "Propeller Shaft Bearing Preload", per procedure in this section.
3. Locate corresponding values along side, and top of chart. Follow columns down and across and observe torque value where they meet.
4. Lower drive shaft upper bearing must be shimmed to obtain this torque value when measured at propeller shaft (refer to procedure in this section). Use torque value for new or used lower drive shaft upper bearings, as appropriate.

X-X ← New Bearing
X-X ← *Used Bearing

*Bearing is considered used if spun under load even once.

LOWER DRIVE SHAFT BEARING PRELOAD TRS GEAR HOUSING

DRIVE SHAFT HOUSING OVERALL BEARING PRELOAD (LBS. IN.)

PROPELLER SHAFT BEARING PRELOAD (LBS. IN.)

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
3	10-14 9-10	11-15 10-11	12-16 11-12	13-17 12-13	14-18 13-14	15-19 14-15	16-20 15-16	17-21 16-17	19-23 18-19	20-24 19-20	21-25 20-21	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	28-32 27-28	29-33 28-29	30-34 29-30	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34
4	11-15 10-11	12-16 11-12	13-17 12-13	14-18 13-14	15-19 14-15	16-20 15-16	17-21 16-17	18-22 17-18	20-24 19-20	21-25 20-21	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	27-31 26-27	29-33 28-29	30-34 29-30	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34	35-39 34-35
5	12-16 11-12	13-17 12-13	14-18 13-14	15-19 14-15	16-20 15-16	17-21 16-17	18-22 17-18	19-23 18-19	21-25 20-21	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	27-31 26-27	28-32 27-28	30-34 29-30	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34	35-39 34-35	36-40 35-36
6	13-17 12-13	14-18 13-14	15-19 14-15	16-20 15-16	17-21 16-17	18-22 17-18	19-23 18-19	20-24 19-20	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	27-31 26-27	28-32 27-28	29-33 28-29	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34	35-39 34-35	36-40 35-36	37-41 36-37
7	14-18 13-14	15-19 14-15	16-20 15-16	17-21 16-17	18-22 17-18	19-23 18-19	20-24 19-20	21-25 20-21	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	27-31 26-27	28-32 27-28	29-33 28-29	30-34 29-30	32-36 31-32	33-37 32-33	34-38 33-34	35-39 34-35	36-40 35-36	37-41 36-37	38-42 37-38
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9	16-20 15-16	17-21 16-17	18-22 17-18	19-23 18-19	20-24 19-20	21-25 20-21	22-26 21-22	23-27 22-23	25-29 24-25	26-30 25-26	27-31 26-27	28-32 27-28	29-33 28-29	30-34 29-30	31-35 30-31	32-36 31-32	34-38 33-34	35-39 34-35	36-40 35-36	37-41 36-37	38-42 37-38	39-43 38-39	40-44 39-40
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11	18-22 17-18	19-23 18-19	20-24 19-20	21-25 20-21	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	27-31 26-27	28-32 27-28	29-33 28-29	30-34 29-30	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34	36-40 35-36	37-41 36-37	38-42 37-38	39-43 38-39	40-44 39-40	41-45 40-41	42-46 41-42
12	19-23 18-19	20-24 19-20	21-25 20-21	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	28-32 27-28	29-33 28-29	30-34 29-30	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34	35-39 34-35	37-41 36-37	38-42 37-38	39-43 38-39	40-44 39-40	41-45 40-41	42-46 41-42	43-47 42-43
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15	22-26 21-22	23-27 22-23	24-28 23-24	25-29 24-25	26-30 25-26	27-31 26-27	28-32 27-28	29-33 28-29	31-35 30-31	32-36 31-32	33-37 32-33	34-38 33-34	35-39 34-35	36-40 35-36	37-41 36-37	38-42 37-38	40-44 39-40	41-45 40-41	42-46 41-42	43-47 42-43	44-48 43-44	45-49 44-45	46-50 45-46

All Values In Chart Are In Lbs. In.

CHART USAGE

1. Measure "Drive Shaft Housing Overall Bearing Preload", as outlined in Section 3-B.
2. Adjust and record "Propeller Shaft Bearing Preload", per procedure in this section.
3. Locate corresponding values along side, and top of chart. Follow columns down and across and observe torque value where they meet.
4. Lower drive shaft upper bearing must be shimmed to obtain this torque value when measured at propeller shaft (refer to procedure in this section). Use torque value for new or used lower drive shaft upper bearings, as appropriate.

X-X ← New Bearing
X-X ← *Used Bearing

*Bearing is considered used if spun under load even once.

Special Tools

Quicksilver

Part No.	Description	Usage	
		TR	TRS
91-31108	Driver		●
91-31229A5	Bearing Removal & Installation Tool	●	
91-33493	Driver		●
91-34569A1	Slide Hammer Puller	●	●
91-37241	Universal Puller Plate	●	●
91-37263	Driver		●
91-37323	Driver Rod	●	●
91-46086A1	Puller Jaws	●	●
91-53459	Indicator Rod	●	●
91-54873	Bearing Carrier Retainer Wrench	●	
91-55916	Driver	●	
91-55918	Driver	●	
91-55919	Driver	●	
91-55922	Driver		●
91-58222A1	Dial Indicator	●	●
91-61069	Bearing Carrier Retainer Wrench	●	
91-63616	Puller	●	●
91-63619	Driver	●	
91-63620A1	Drive Shaft Socket Tool	●	●
91-63622	Shimming Tool	●	
91-63626	Driver	●	
91-63638	Driver	●	
91-66274	Torque Wrench	●	●
91-67441	Shimming Tool		●
91-67443	Driver		●
91-68891	Driver	●	●
91-89897	Holding Tool	●	●

Others

- 0 In. - 1 In. Depth Micrometer

Lubricants, Adhesives and Sealers

- Quicksilver Loctite "A", 92-32609
- Quicksilver Perfect Seal, 92-34227
- Quicksilver Needle Bearing Assembly Lubricant, 92-42649A1
- Quicksilver Super-Duty Lower Unit Lubricant (*)
- Quicksilver Special Lubricant 101, 92-79214A1
- Quicksilver 2-4-C Multi-Lube, 92-90018A12
- Quicksilver Bellows Adhesive, 92-86166
- Quicksilver Adhesive, 92-25234-1

* Refer to "Quicksilver Accessory Guide" for part numbers.

Description

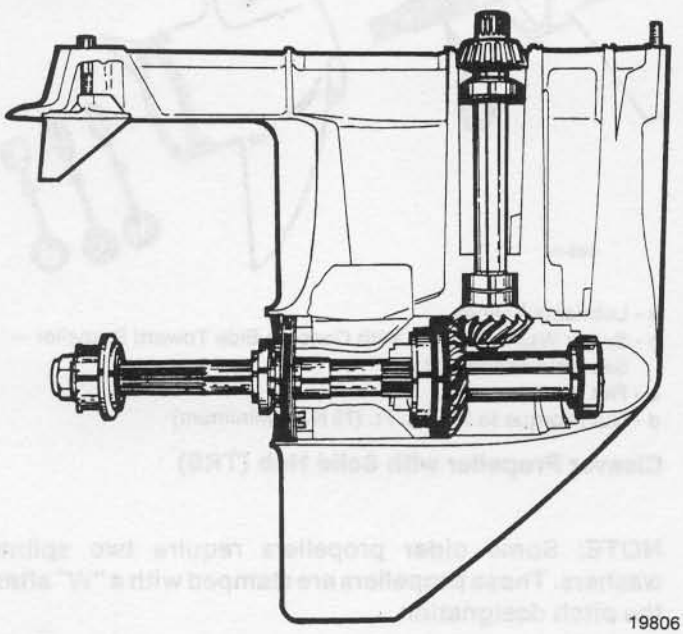
The TR and TRS gear housings differ only in the physical size of the components used.

The TR gear housing utilizes larger components and is capable of turning up to 20" diameter propeller. This makes this unit ideally suited for use on larger pleasure boats, house boats and work boats.

The TRS gear housing is smaller to minimize "drag" as it passes thru the water. This unit is designed for use on hi-performance, sport boats that are capable of speeds above 45 MPH. Only hi-performance propellers (Cleaver, Laser™, etc.) are recommended for use on these units. The use of these propellers allow the stern drive to be mounted higher on the transom than normal for increased performance.

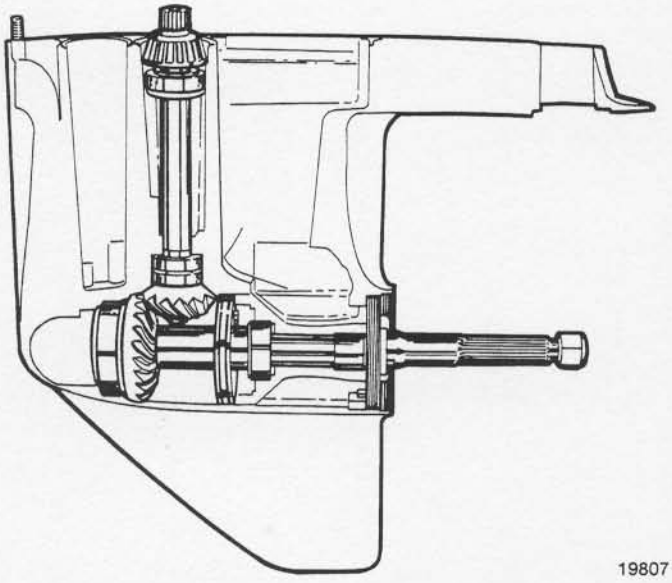
Propeller Rotation

Both the TR and TRS stern drive units are available in either right hand or left hand rotation. Propeller rotation is determined by the location of the driven gear in gear housing.



19806

Right Hand Rotation



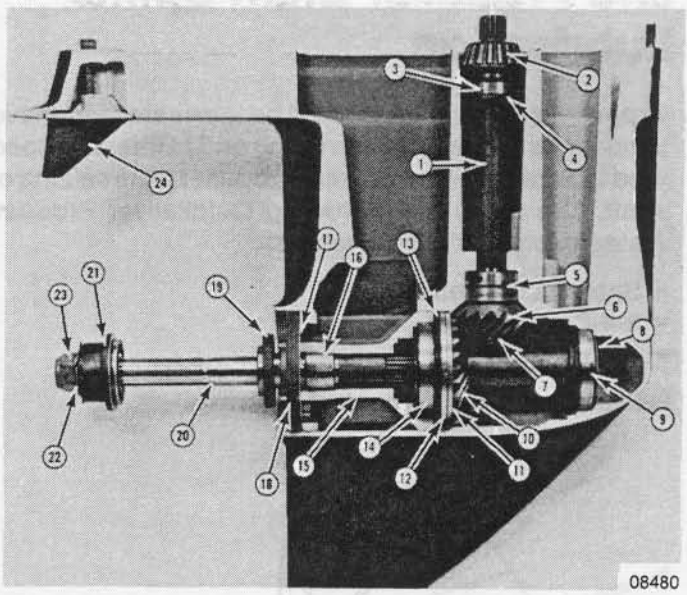
19807

Left Hand Rotation

Different propeller shafts and bearings are used in the right hand and left hand rotation gear housings. All other components are the same.

NOTE: Right hand rotation gear housing will have a "RH" stamped on end of propeller shaft. Left hand rotation gear housings will have a "LH" stamped on end of propeller shaft or will not have any marking at all.

Component Parts



08480

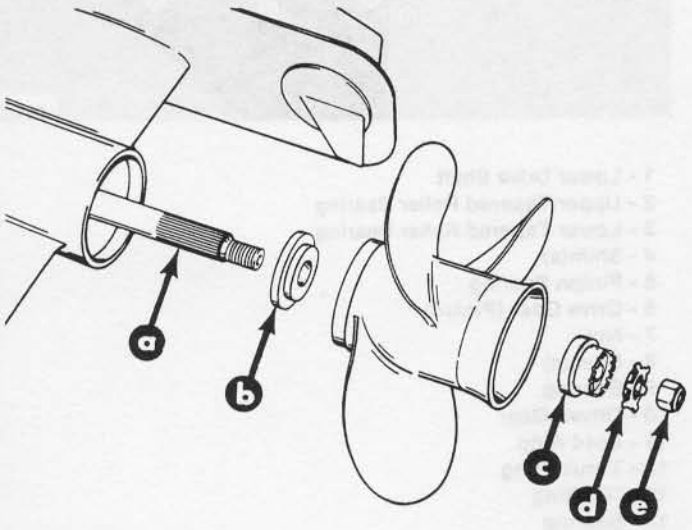
1 - Lower Drive Shaft
2 - Upper Tapered Roller Bearing
3 - Lower Tapered Roller Bearing
4 - Shim(s)
5 - Pinion Bearing
6 - Drive Gear (Pinion)
7 - Nut
8 - Shim(s)
9 - Bearing
10 - Driven Gear
11 - Load Ring
12 - Thrust Ring
13 - "O" Ring
14 - Bearing
15 - Bearing Carrier
16 - Needle Bearing
17 - Tab Washer
18 - Threaded Retainer
19 - Forward Thrust Hub and Washer Assembly
20 - Propeller Shaft
21 - Spline Washer Assembly
22 - Tab Washer
23 - Nut
24 - Trim Tab

Propeller Removal, Installation, and Propeller Shaft Spline Lubrication

Propeller shaft splines should be lubricated whenever propeller is removed for servicing and at intervals specified in Section 1-B to prevent propeller from seizing on shaft. Use one of the following Quicksilver Products (listed in order of effectiveness):

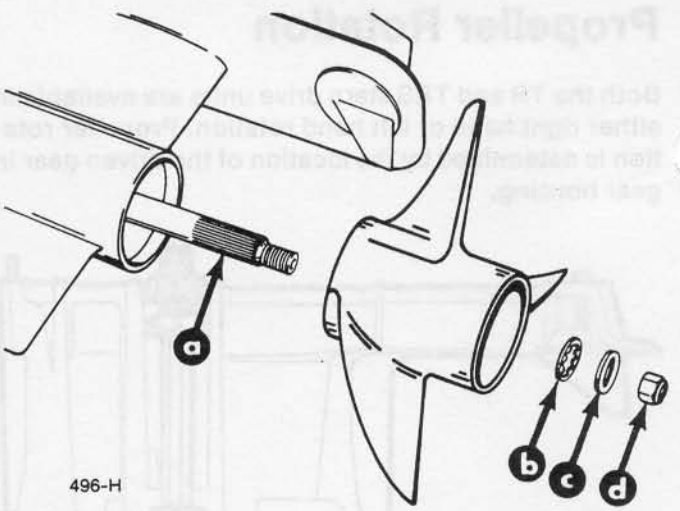
- Special Lubricant 101
- 2-4-C Multi-Lube
- Perfect Seal

Remove and install propeller as shown.



a - Lubricate Splines
b - Thrust Hub and Washer Assembly
c - Spline Washer Assembly
d - Tab Washer (Bend 3 Tabs Down Into Spline Washer to Secure)
e - Nut [Torque to 55 Lbs. Ft. (75 N.m) Minimum]

TR Propeller

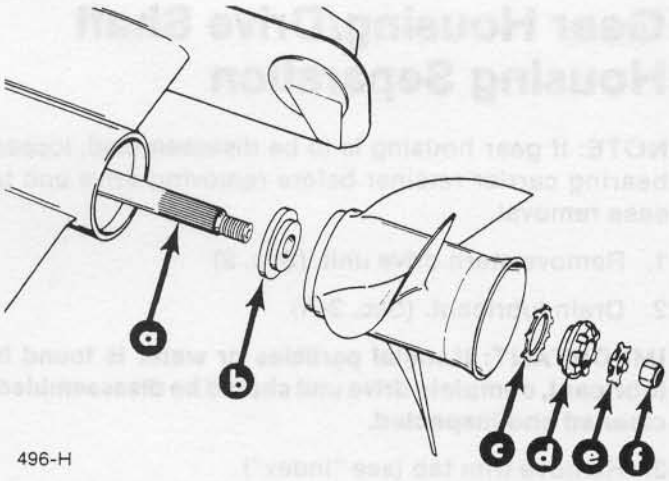


496-H

a - Lubricate Splines
b - Spline Washer (Install With Concave Side Toward Propeller -- See Note Following)
c - Flat Washer
d - Nut [Torque to 55 Lbs. Ft. (75 N.m) Minimum]

Cleaver Propeller with Solid Hub (TRS)

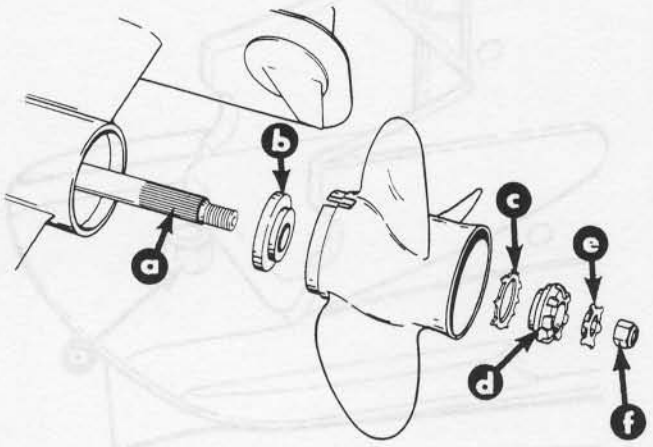
NOTE: Some older propellers require two spline washers. These propellers are stamped with a "W" after the pitch designation.



496-H

a - Lubricate Splines
b - Thrust Hub
c - Continuity Washer (If So Equipped -- See Note Following)
d - Spline Washer
e - Tab Washer (Bend 3 Tabs Down Into Spline Washer to Secure)
f - Nut [Torque to 55 Lbs. Ft. (75 N.m) Minimum]

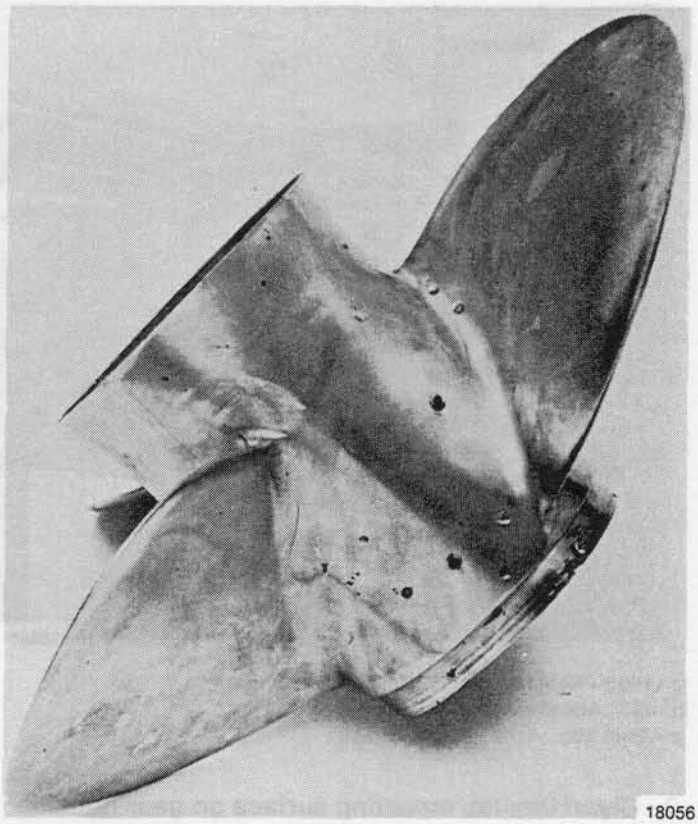
Cleaver Propeller with Rubber Hub (TRS)



a - Lubricate Splines
b - Thrust Hub
c - Continuity Washer (If So Equipped -- See Note Following)
d - Spline Washer
e - Tab Washer (Bend 3 Tabs Down Into Spline Washer to Secure)
f - Nut [Torque to 55 Lbs. Ft. (75 N.m) Minimum]

Laser™ Propeller (TRS)

NOTE: Continuity Washer, 13-42351 is recommended to help ensure a good ground between propeller and shaft, which is essential to prevent propeller from corroding. Washer is provided with new propellers. Corrosion damage from loss of continuity is shown below.

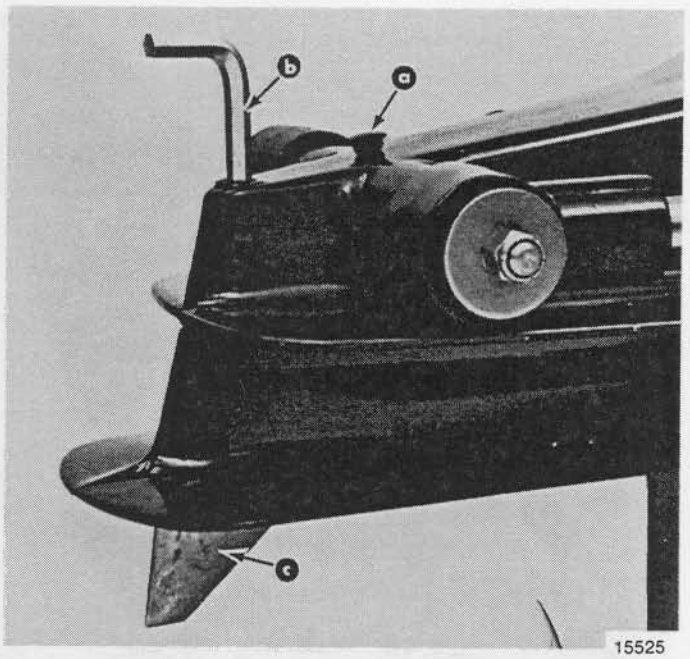


18056

Trim Tab Replacement

Trim tab must be replaced when erosion reaches 50%.

1. Remove trim tab.



a - Plug - Remove from Drive Shaft Housing
b - 3/8" Allen Wrench
c - Trim Tab

2. Clean trim tab mounting surface on gear housing. Surface must be clean for trim tab to provide corrosion protection.
3. Install new trim tab with trailing edge straight back.

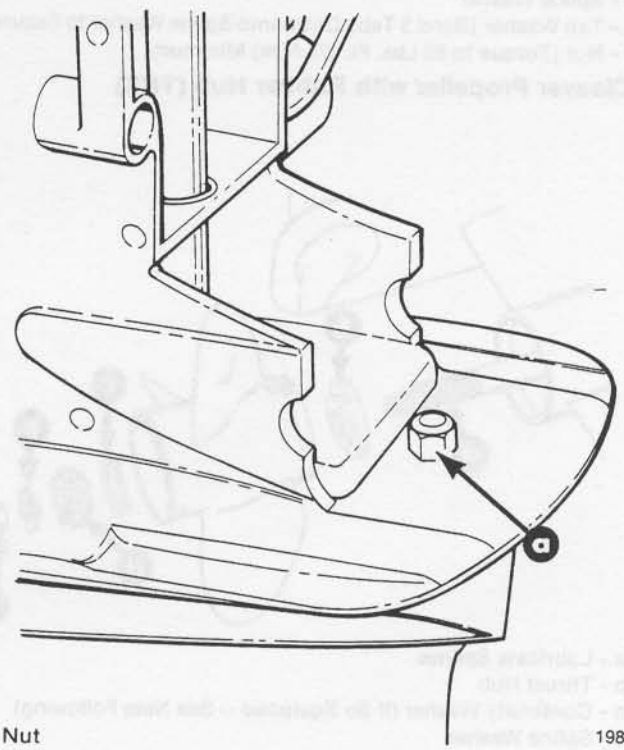
Gear Housing/Drive Shaft Housing Separation

NOTE: If gear housing is to be disassembled, loosen bearing carrier retainer before removing drive unit to ease removal.

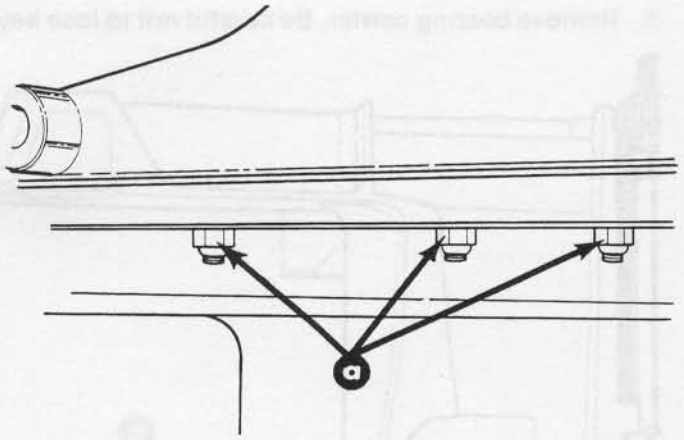
1. Remove stern drive unit. (Sec. 2)
2. Drain lubricant. (Sec. 3-A)

IMPORTANT: If metal particles or water is found in lubricant, complete drive unit should be disassembled, cleaned and inspected.

3. Remove trim tab (see "Index").
4. Remove attaching hardware and separate drive shaft housing from gear housing.

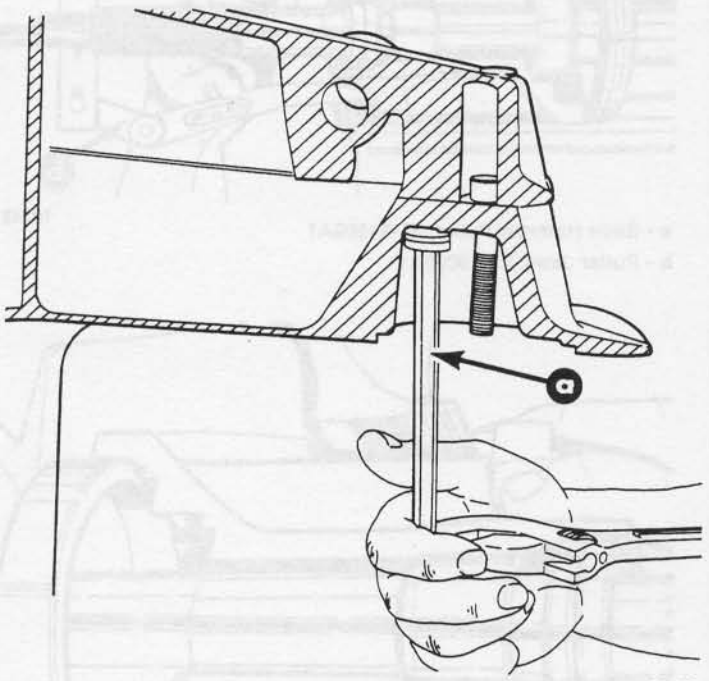


a - Nut



19810

a - 3 Nuts Each Side

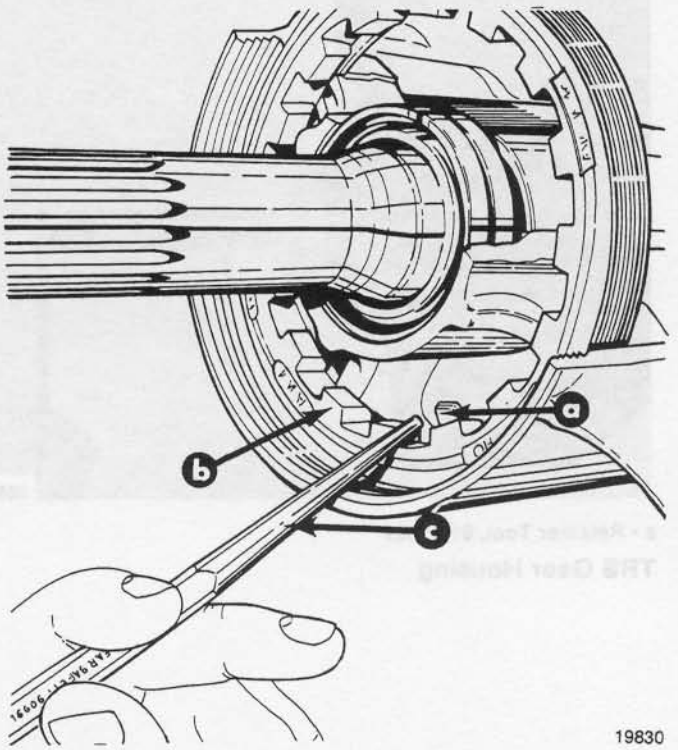


19918

a - Allen Wrench

Major Component Disassembly

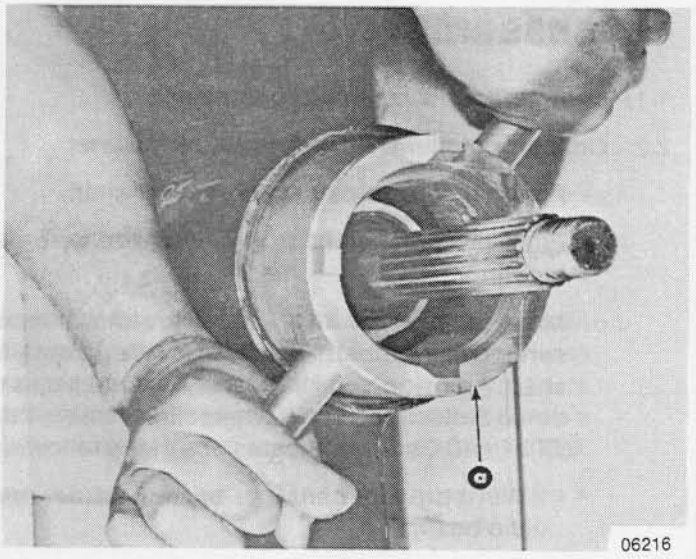
1. Mount gear housing in a repair stand.
2. Check propeller shaft for runout, as follows:
   a. Position dial indicator on propeller shaft.
   b. Push propeller shaft to one side and zero dial indicator.
   c. Move propeller shaft to opposite side while observing dial indicator. Without rotating propeller shaft, reposition dial indicator and check up and down deflection. A shaft deflection of more than .003 in. (0.08mm) indicates one of the following:
      - Worn propeller shaft or bearing carrier needle bearing.
      - Improper propeller shaft bearing preload.
   d. Rotate propeller shaft while observing dial indicator. If deflection is more than .005 in. (.127mm), a bent propeller shaft is indicated.
3. Straighten tab on tab washer.



19830

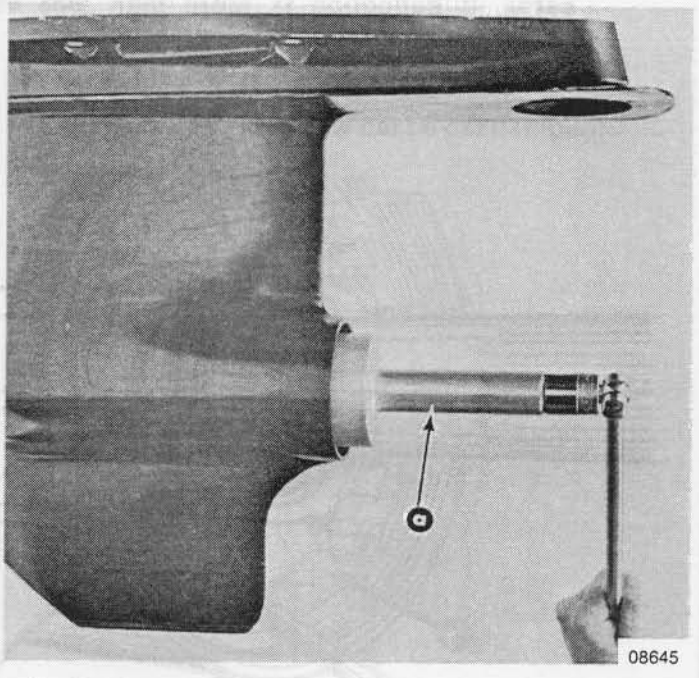
a - Tab Washer
b - Threaded Retainer
c - Punch

4. Remove threaded retainer.



a - Retainer Tool, 91-54873

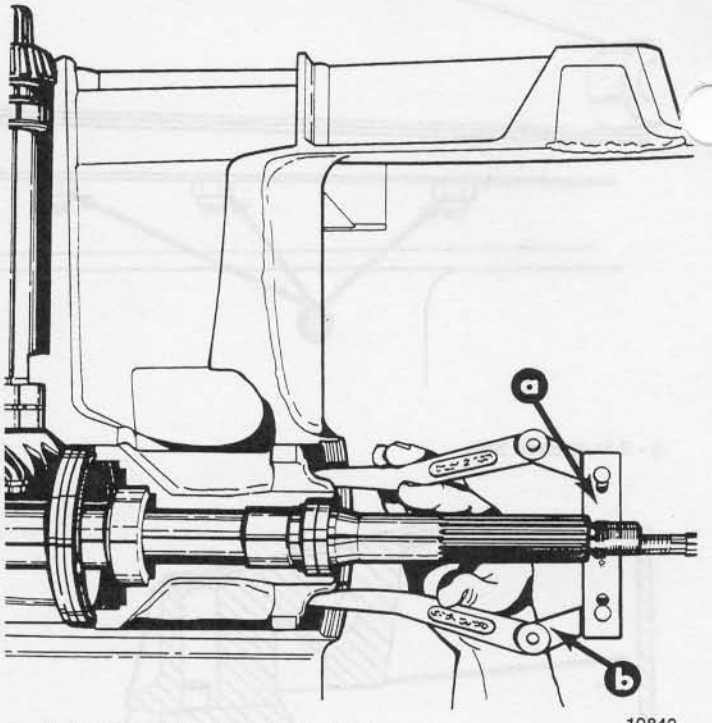
TR Gear Housing



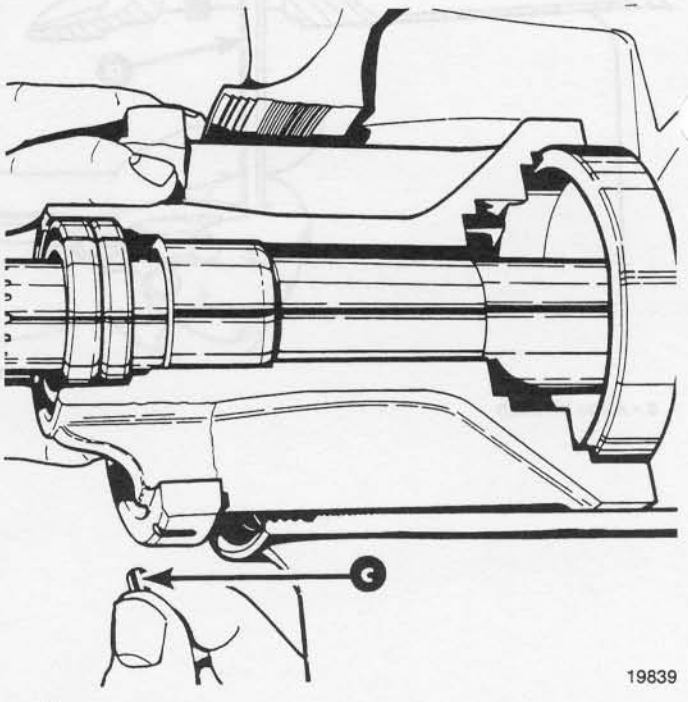
a - Retainer Tool, 91-61069

TRS Gear Housing

5. Remove bearing carrier. Be careful not to lose key.

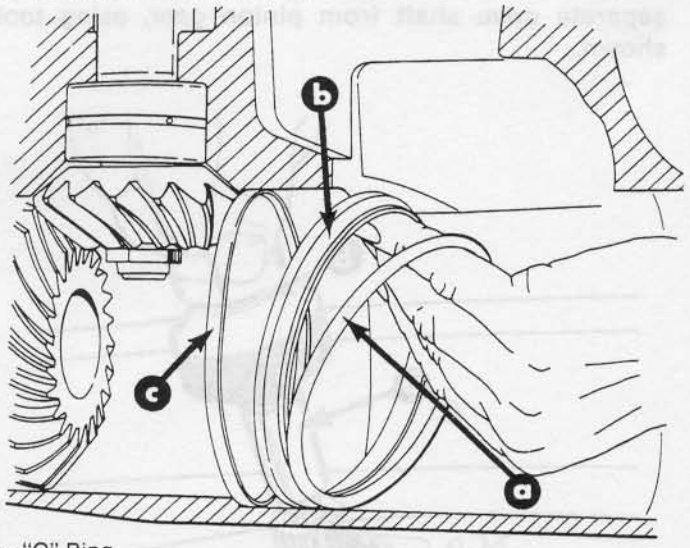


a - Slide Hammer Puller, 91-34569A1
b - Puller Jaws, 91-45086A1



c - Key

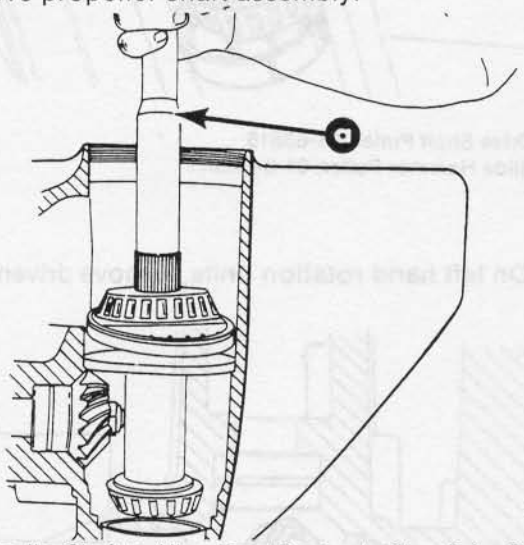
6. Remove items shown.



19911

a - "O" Ring
b - Thrust Ring
c - Load Ring

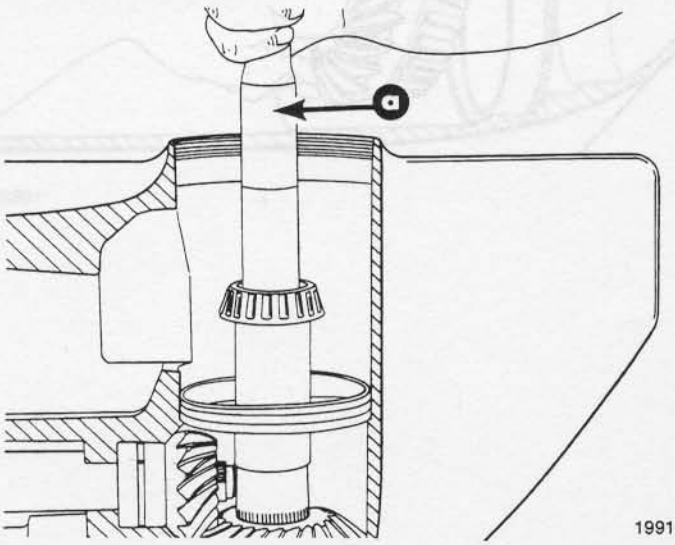
7. Remove propeller shaft assembly.



19912

a - Tilt Propeller Shaft to Allow Front Bearing to Clear Drive Gear

Right Hand Rotation

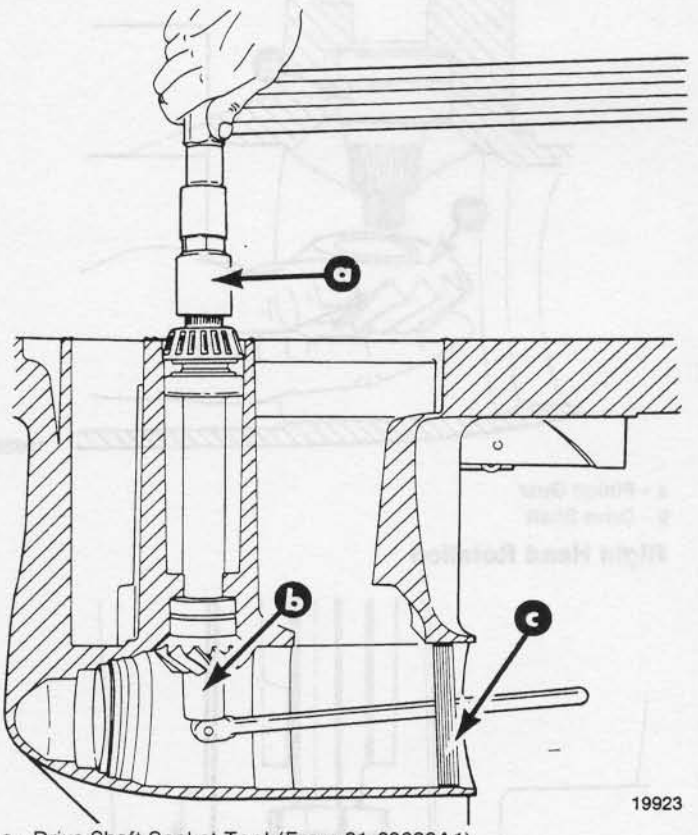


19916

a - Lift Propeller Shaft from Gear Housing

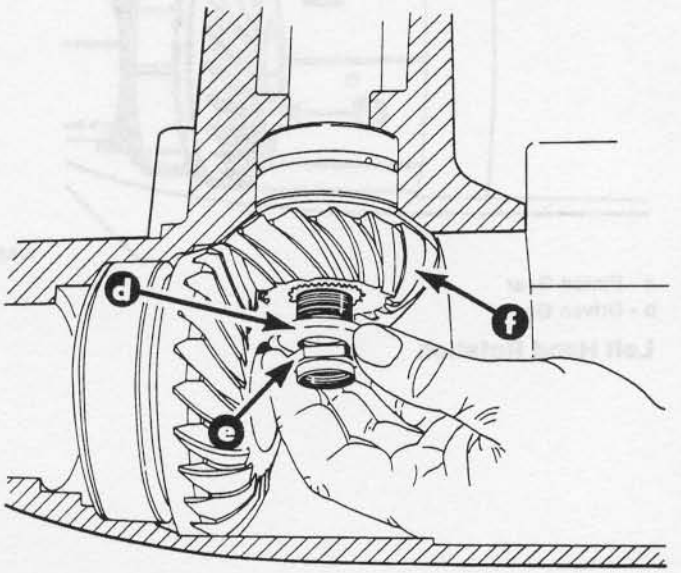
Left Hand Rotation

8. Reinstall threaded retainer in gear housing to protect threads in housing. Remove pinion gear nut and washer.



19923

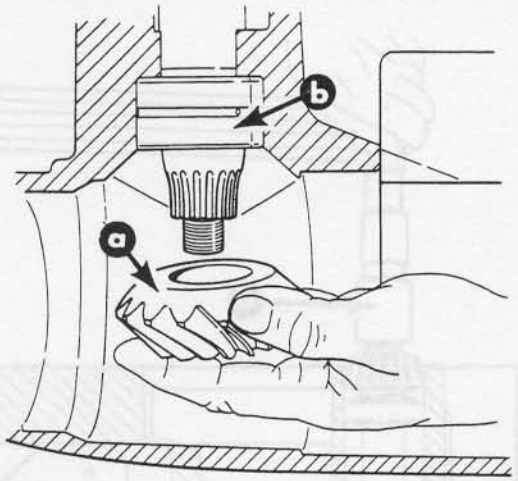
a - Drive Shaft Socket Tool (From 91-63620A1)
b - Breaker Bar and Socket
c - Threaded Retainer



19924

d - Washer
e - Nut
f - Pinion Gear

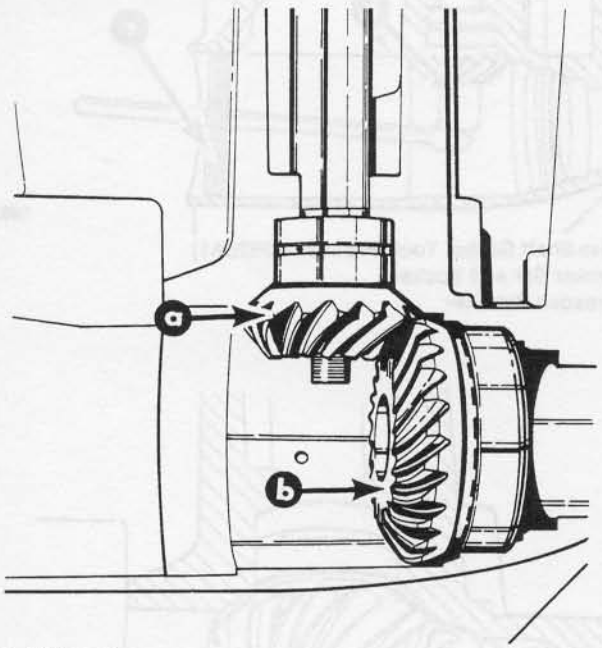
9. Separate drive shaft from pinion gear and remove pinion gear. (See "Note" following.)



19926

a - Pinion Gear
b - Drive Shaft

Right Hand Rotation

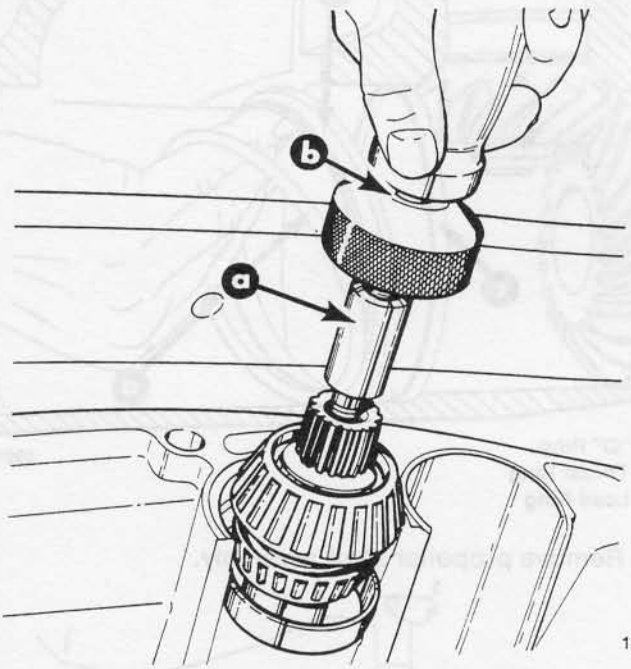


19835

a - Pinion Gear
b - Driven Gear

Left Hand Rotation

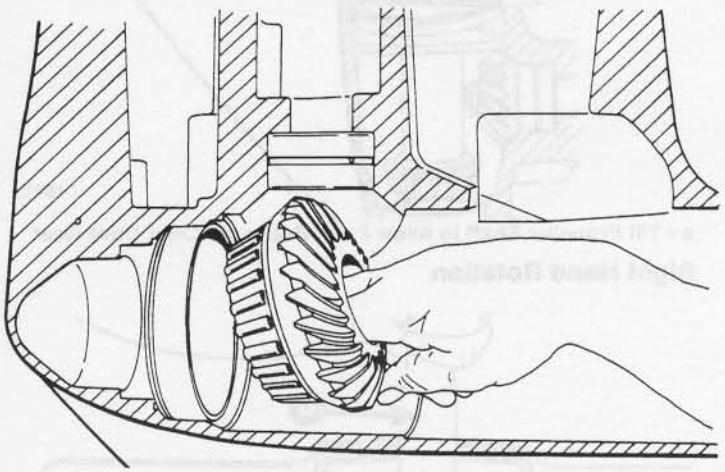
NOTE: It may be necessary, in some instances, to separate drive shaft from pinion gear, using tools shown.



19812

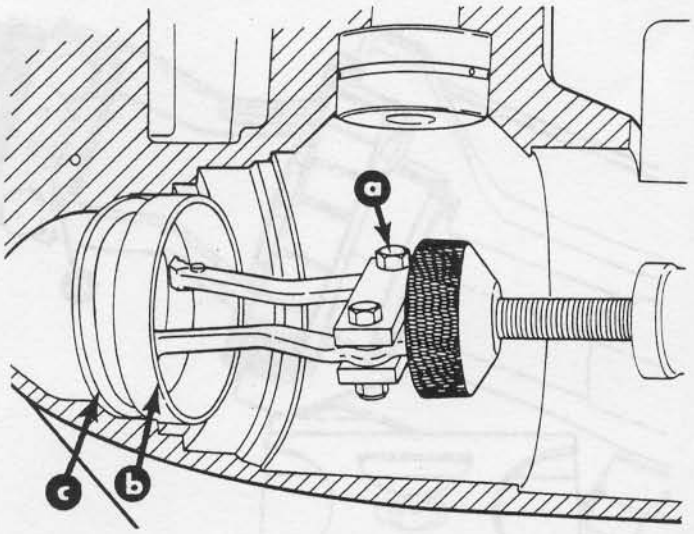
a - Drive Shaft Puller, 91-63616
b - Slide Hammer Puller, 91-34569A1

10. On left hand rotation units, remove driven gear.



19925

11. Remove bearing cup and shims from gear housing.



a - Slide Hammer Puller, 91-34569A1
b - Bearing Cup
c - Shims

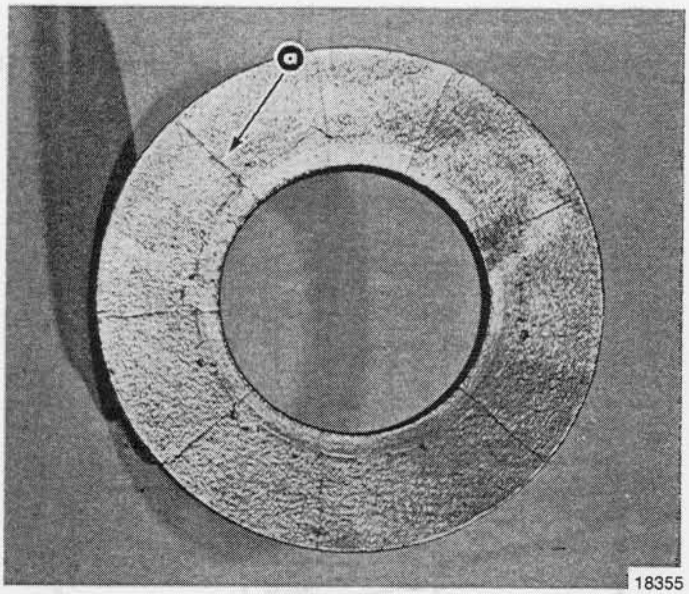
NOTE: Gear housing components can be inspected with housing disassembled to this point. DO NOT remove driven gear and drive shaft bearing cones, bearing carrier needle bearing or pinion bearing unless replacement is necessary.

Subassembly Cleaning and Inspection

Refer to "Basic Cleaning and Inspection" (Sec. 1-C). Important points of attention are outlined following.

Pinion Gear Washer

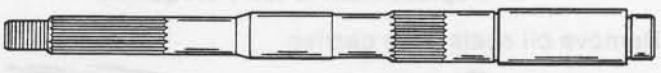
Replace washer if it is cracked.



a - Radial Crack

Propeller Shaft

Check shaft for bent condition [.005 in. (.127mm) maximum].



Subassembly Servicing

Bearing Carrier

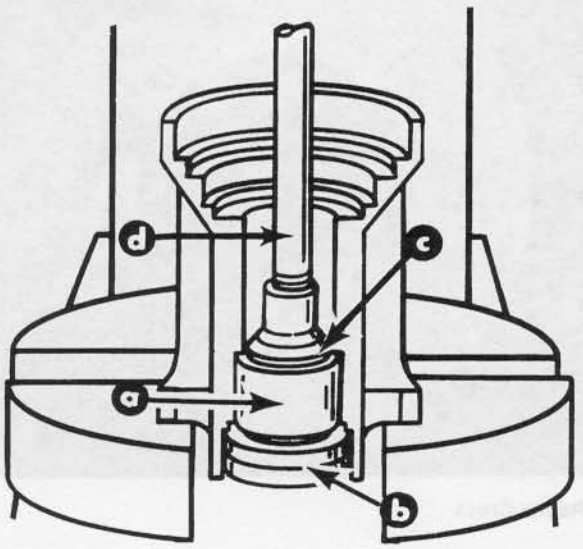
DISASSEMBLY

1. Perform Method "A" or "B", following:

Method "A" - If Replacing Propeller Shaft Needle Bearing

Press needle bearing and oil seals from carrier.

NOTE: Needle bearing MUST BE replaced, if removed.

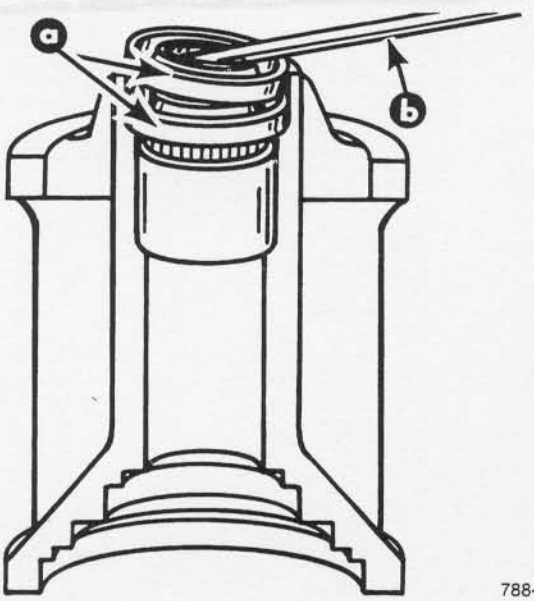


19829

a - Needle Bearing - Replace If Removed
b - Oil Seals (2)
c - Driver - TR: 91-55919
TRS: 91-36569
d - Driver Rod

Method "B" - If Propeller Shaft Needle Bearing Replacement is NOT Required

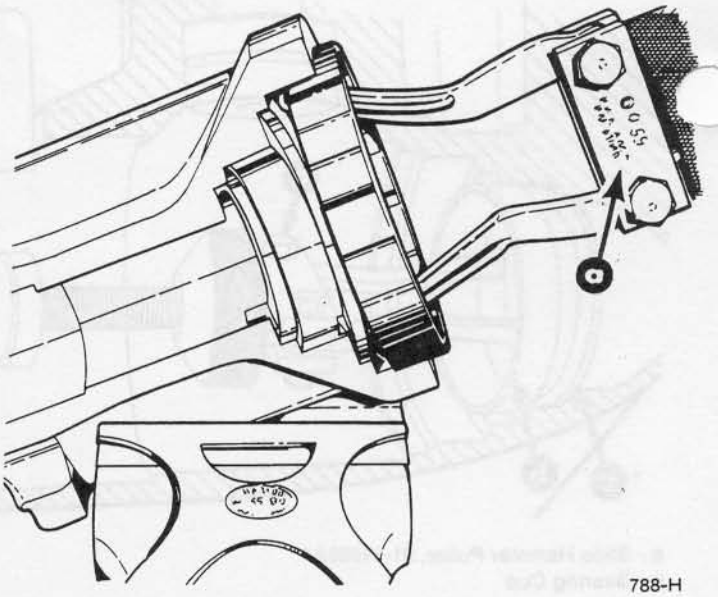
Remove oil seals from carrier.



788-H

a - Oil Seals (2)
b - Pry Bar

2. Remove bearing cup.

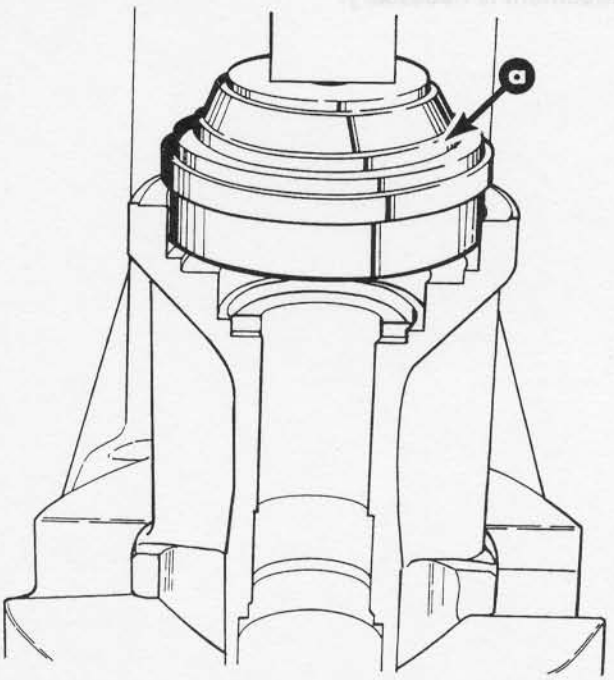


788-H

a - Slide Hammer Puller, 91-34569A1

REASSEMBLY

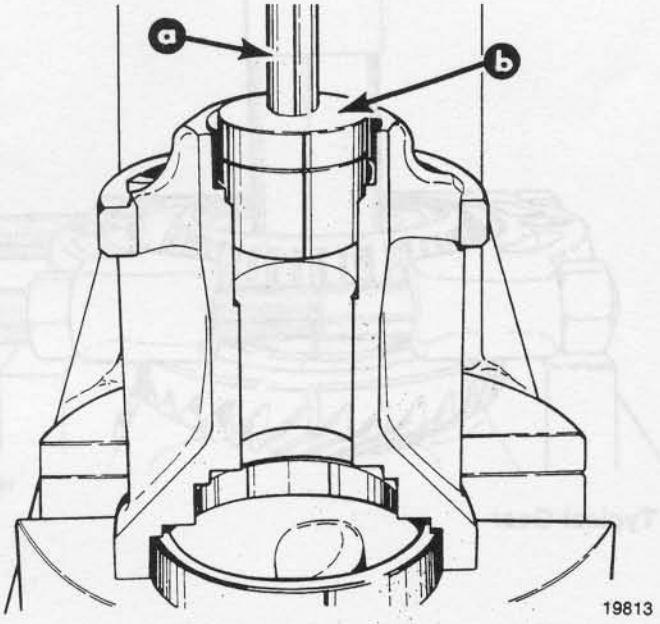
1. Install bearing cup.



19811

a - Driver - TR: 91-63626
TRS: 91-67443

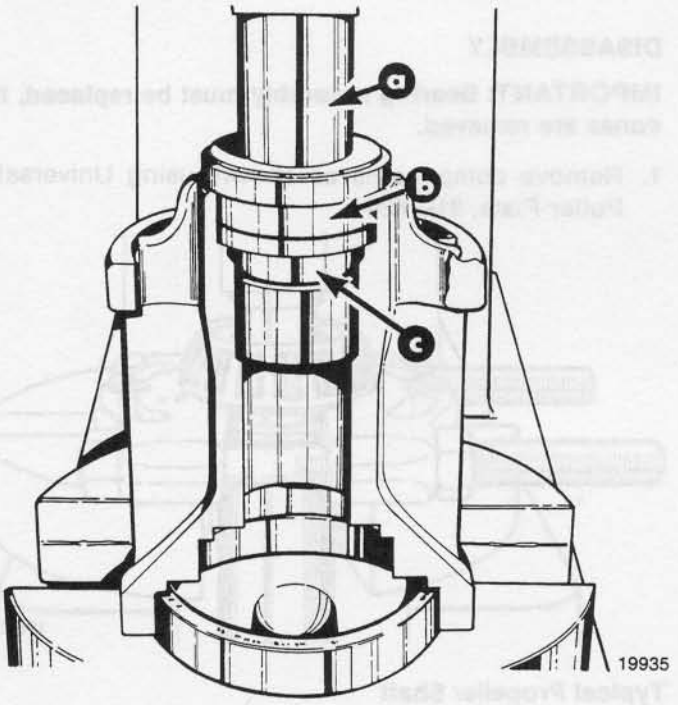
2. Install needle bearing.

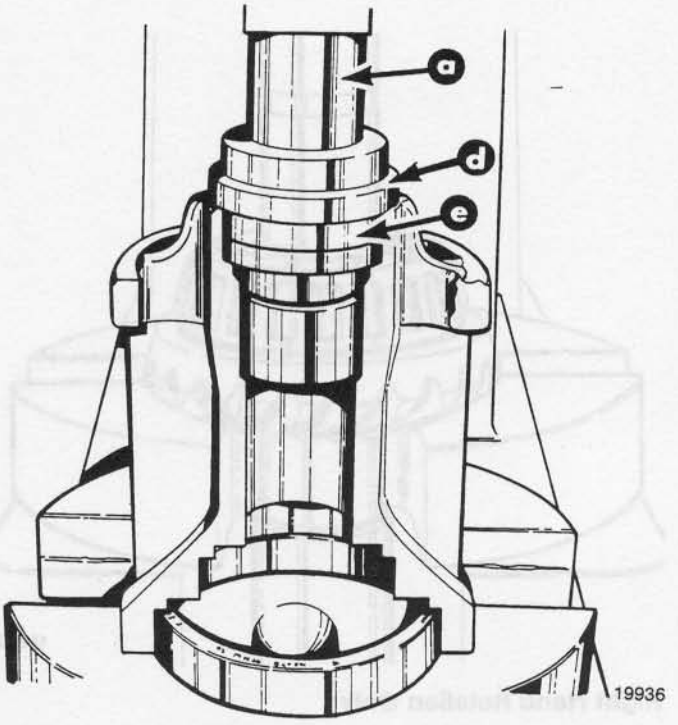


a - Driver Rod, *91-37323
b - Bearing Adaptor,
TR : 91-55918
TRS: *91-37263

*Contained in Bearing Removal and Installation Tool, 91-31229A5.

3. Install oil seals.





a - Driver Tool - TR: 91-55916
TRS: 91-31108
b - Wide Shouldered End
c - Inner Oil Seal
d - Narrow Shouldered End
e - Outer Oil Seal

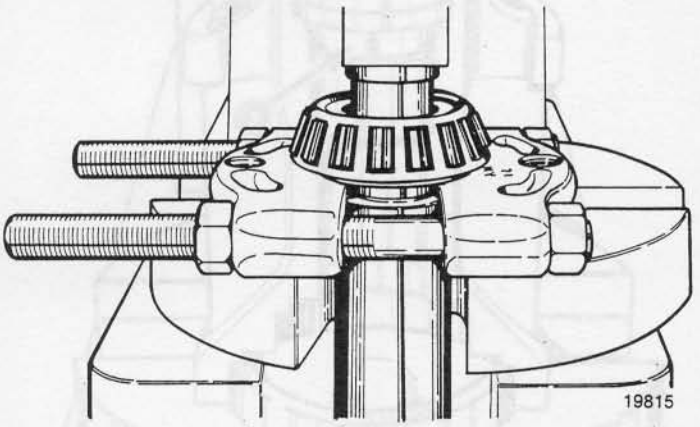
4. Fill spacer between oil seals with 2-4-C Multi-Lube.

Propeller Shaft and Driven Gear

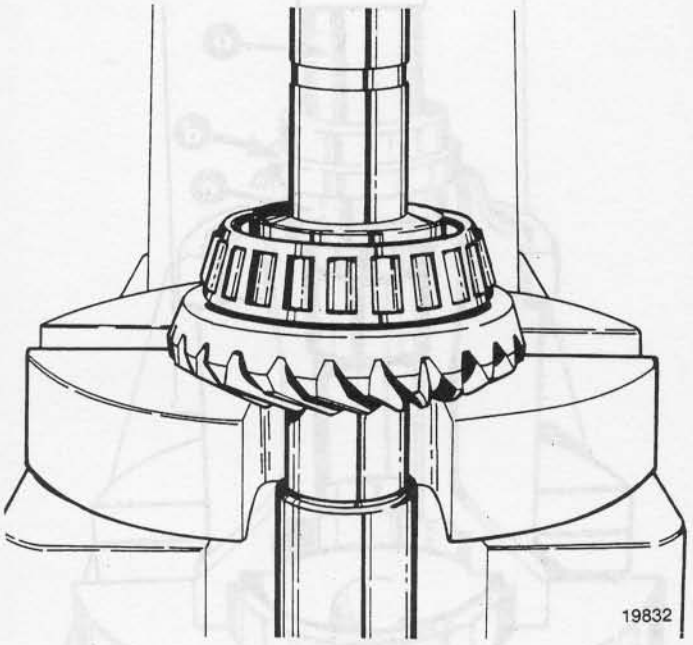
DISASSEMBLY

IMPORTANT: Bearing assembly must be replaced, if cones are removed.

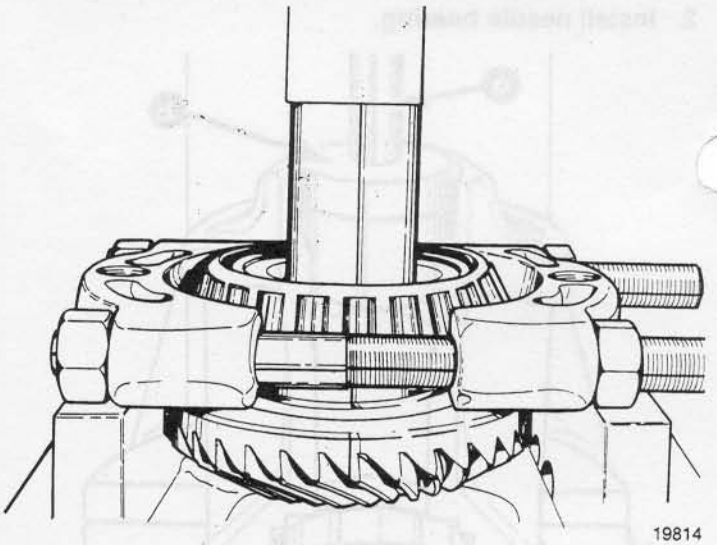
1. Remove components as shown, using Universal Puller Plate, 91-37241.



Typical Propeller Shaft



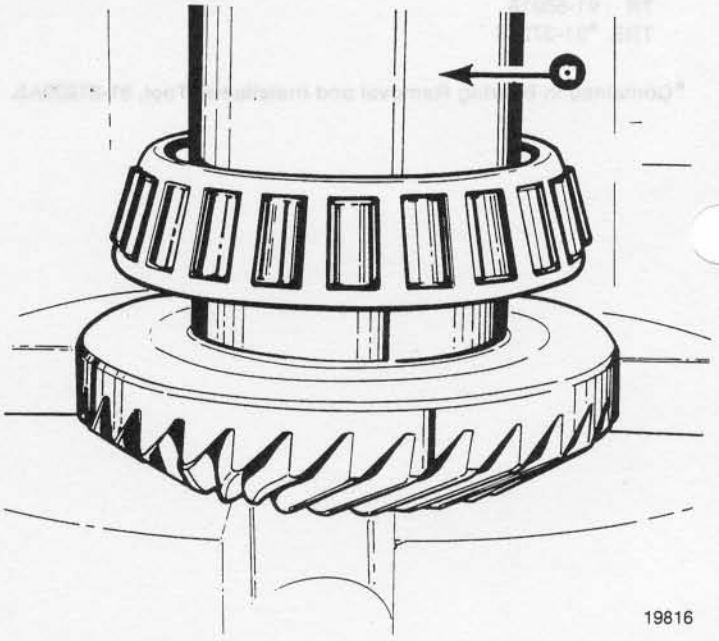
Right Hand Rotation Only



Typical Gear

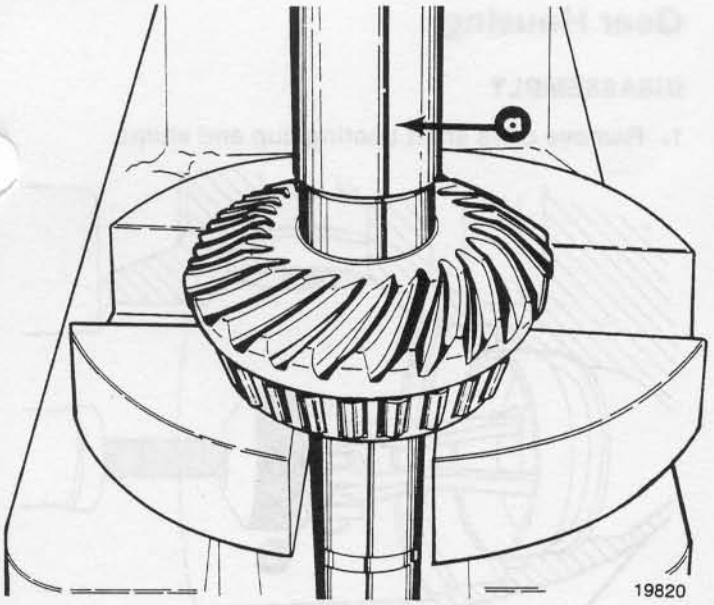
REASSEMBLY

1. Install components as shown.



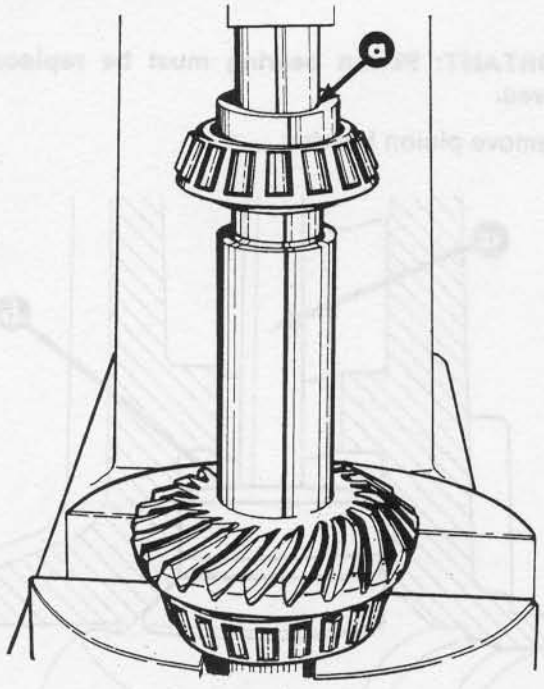
a - Suitable Mandrel

Typical Gear



a - Suitable Mandrel

Right Hand Rotation Only



a - Suitable Mandrel

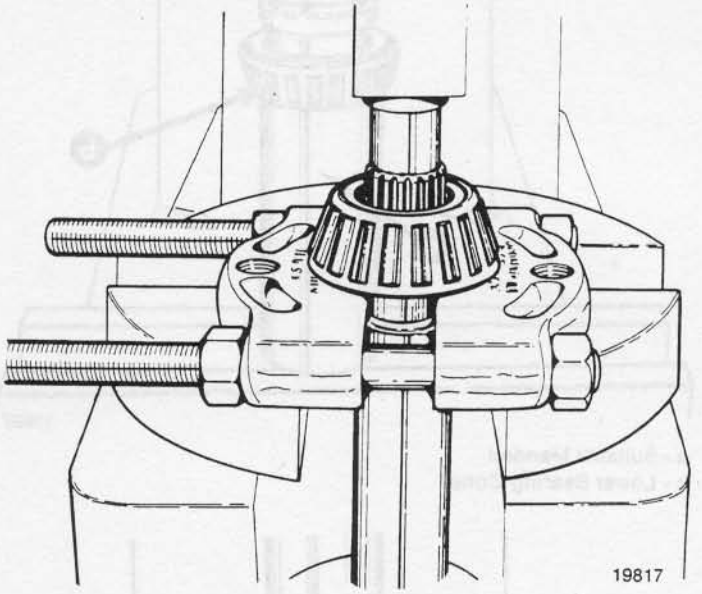
Typical Propeller Shaft

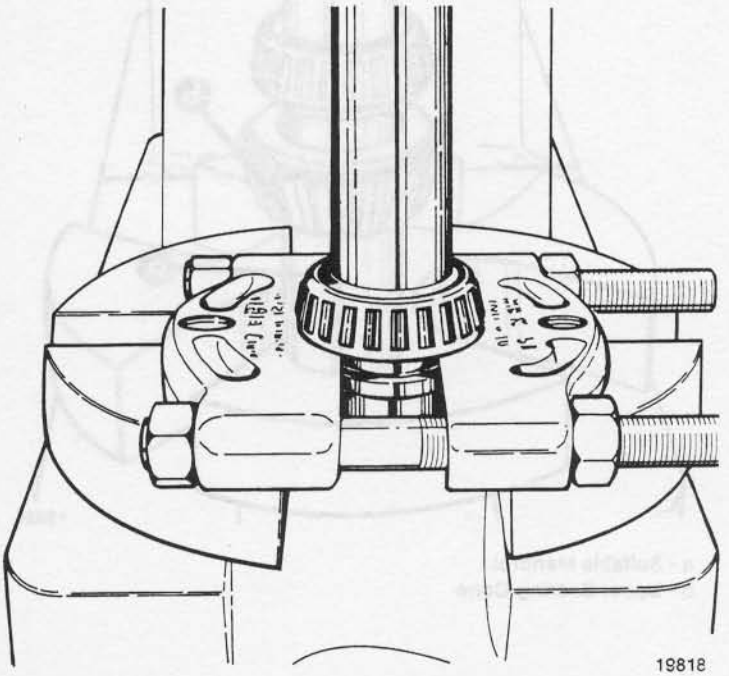
Drive Shaft

DISASSEMBLY

IMPORTANT: Bearing assembly must be replaced, if cones are removed.

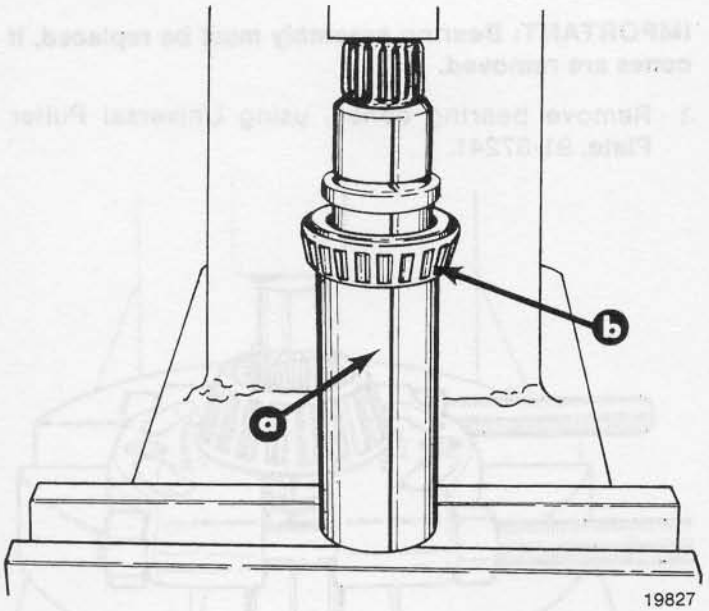
1. Remove bearing cones, using Universal Puller Plate, 91-37241.





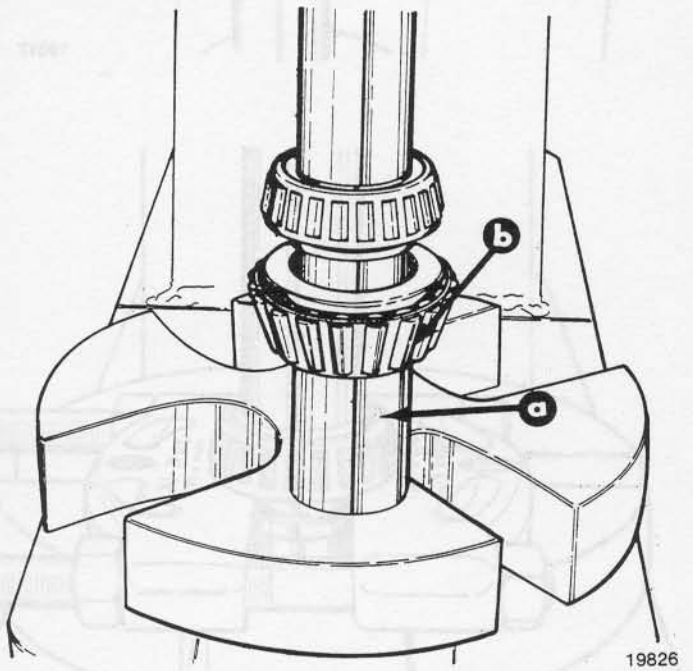
REASSEMBLY

1. Install bearing cones.



19827

a - Suitable Mandrel
b - Lower Bearing Cone



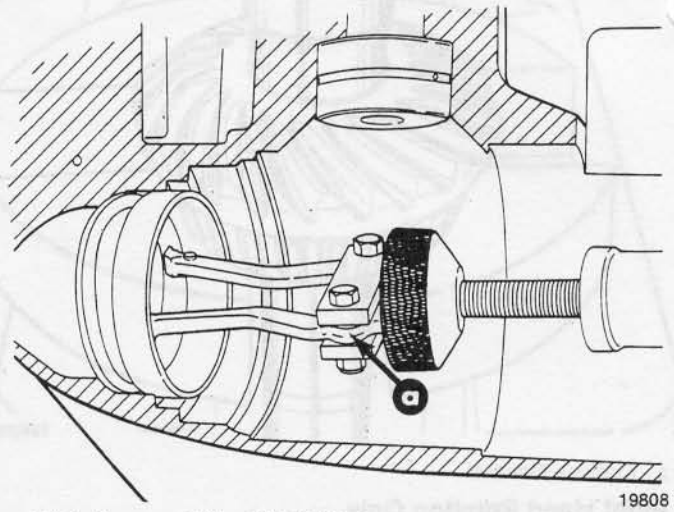
19826

a - Suitable Mandrel
b - Upper Bearing Cone

Gear Housing

DISASSEMBLY

1. Remove drive shaft bearing cup and shims.

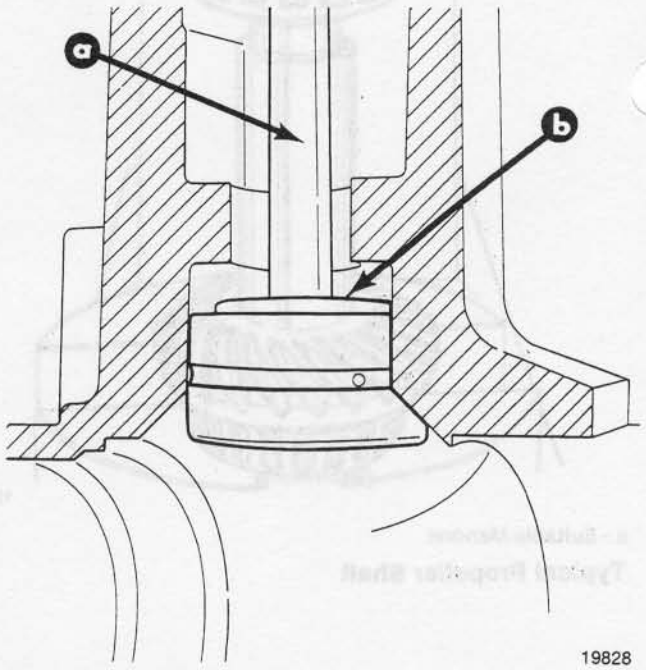


19808

a - Slide Hammer Puller 91-34569A1

IMPORTANT: Pinion bearing must be replaced if removed.

2. Remove pinion bearing.



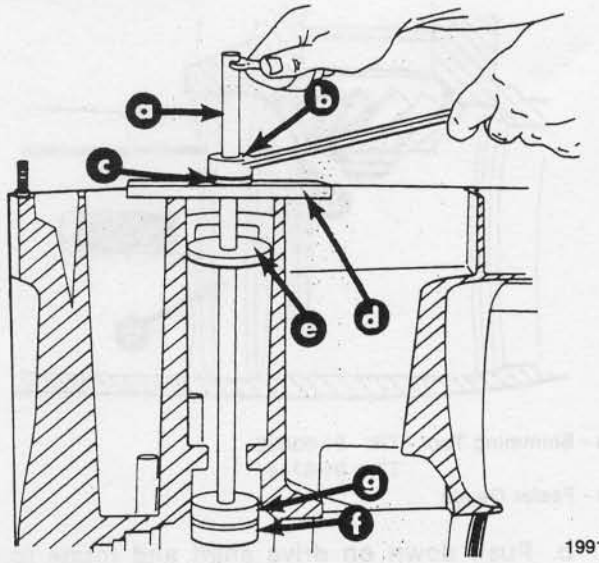
19828

a - *Driver Rod, 91-37323
b - Driver 91-68891

*Contained in Bearing Removal and Installation Kit, 91-31229A5.

REASSEMBLY

1. Install pinion bearing.

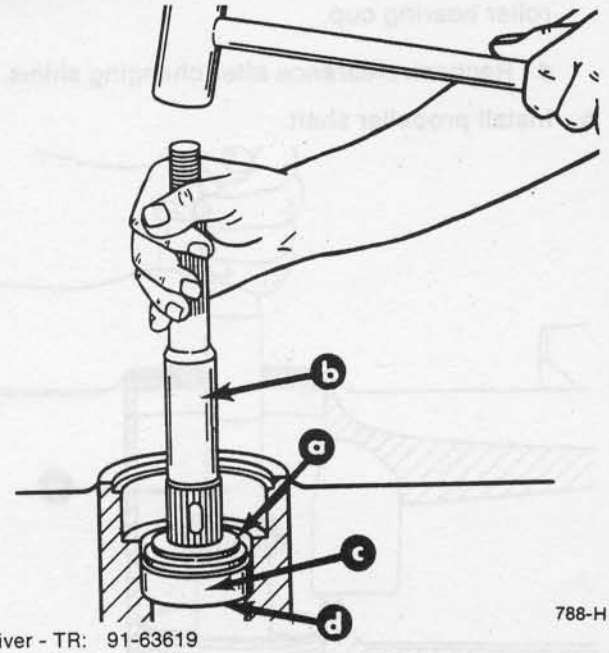


19910

a - *Puller Shaft
b - *Nut
c - *Washer
d - *Plate
e - Pilot
f - Driver - TR: 91-63638
TRS: 91-55922
g - Roller Bearing

*Contained in Bearing Removal and Installation Kit, 91-31229A5.

2. Install drive shaft bearing cup with original thickness shims.

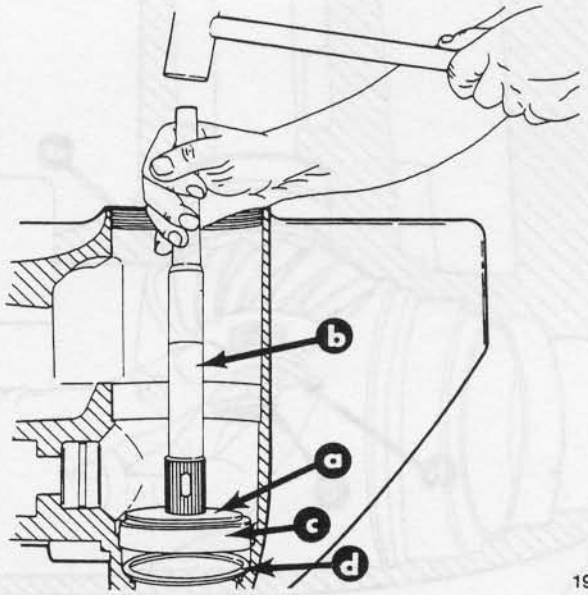


788-H

a - Driver - TR: 91-63619
TRS: 91-67443
b - Old MC-I Propeller Shaft
c - Bearing Cup
d - Shim(s)

NOTE: If a MC-I propeller shaft is not available, use Driver Rod 91-37323 (from Bearing Removal and Installation Kit, 91-31229A5).

3. Install propeller shaft bearing cup with original thickness shims.



19917

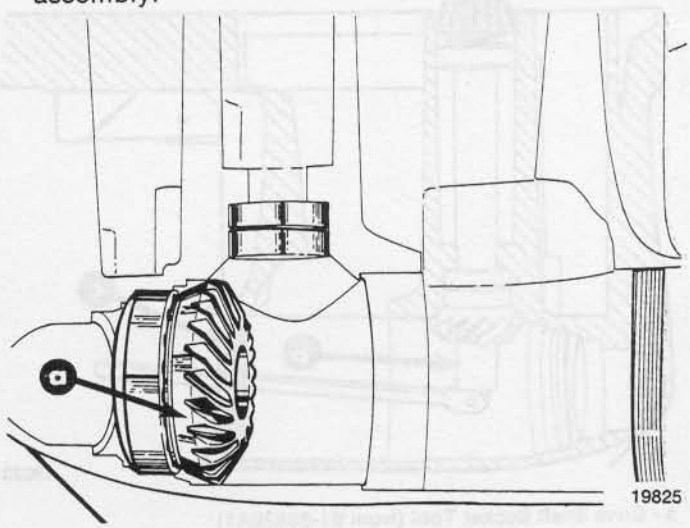
a - Driver - TR: 91-63619
TRS: 91-33493
b - Old MC-I Propeller Shaft
c - Bearing Cup
d - Shim(s)

NOTE: If a MC-I propeller shaft is not available, use Driver Rod 91-37323 (from Bearing Removal and Installation Kit, 91-31229A5).

Major Component Reassembly and Shimming

IMPORTANT: Lubricate gears and bearings with Super-Duty Lower Unit Lubricant before installing. Components must be lubricated to obtain an accurate propeller shaft bearing preload reading, following.

1. On left hand rotation units, install driven gear assembly.

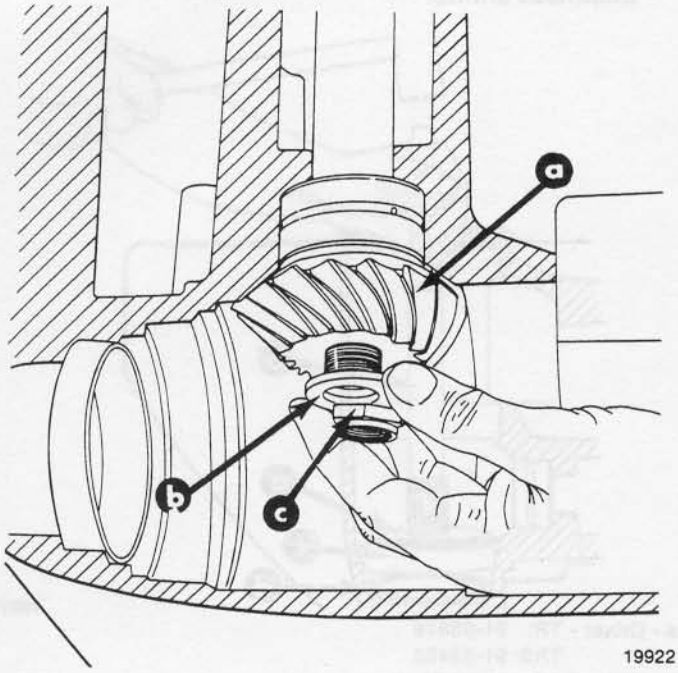


19825

a - Driven Gear Assembly (Left Hand Rotation Units)

Left Hand Rotation Only

2. Install drive shaft and pinion gear.

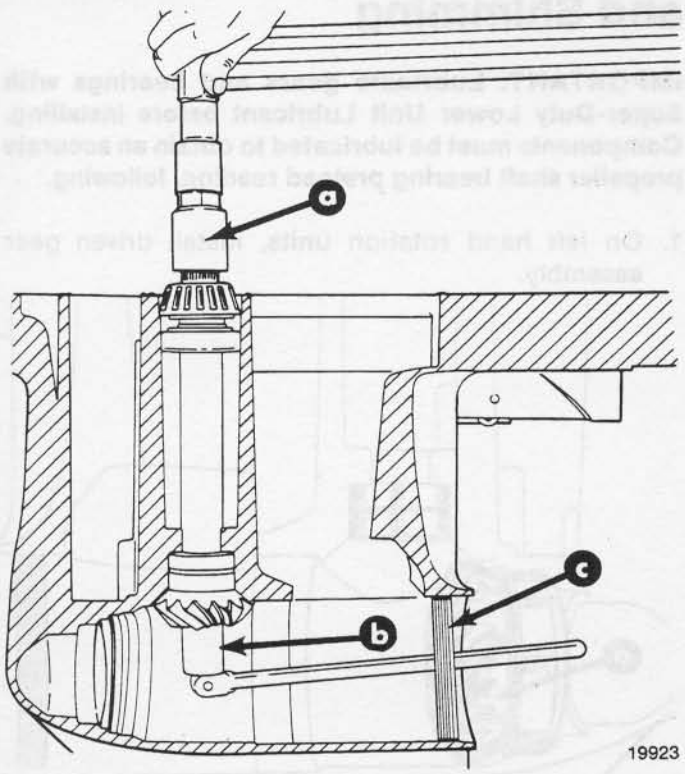


19922

a - Pinion Gear
b - Pinion Washer (Install with Hollow Side Toward Gear)
c - Nut (See Note)

NOTE: Apply Loctite "A" to threads of nut when reassembly unit for the final time (after checking shimming, Step 8).

3. Torque pinion nut to 150 lbs. ft. (1035 kPa).

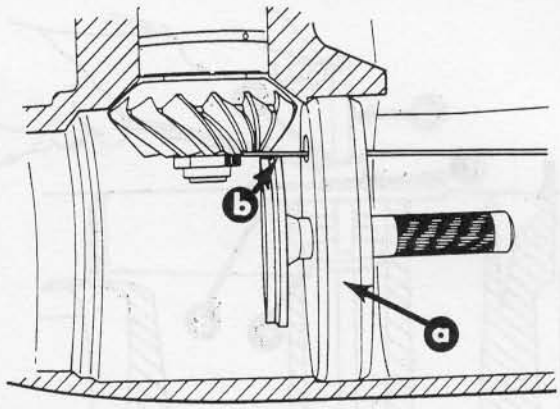


19923

a - Drive Shaft Socket Tool (from 91-63620A1)
b - Breaker Bar and Socket
c - Threaded Retainer

4. Pinion Gear Shimming

a. Insert shimming tool in gear housing.



19920

a - Shimming Tool - TR: 91-63622
TRS: 91-67441
b - Feeler Gauge

b. Push down on drive shaft and rotate to seat bearing.

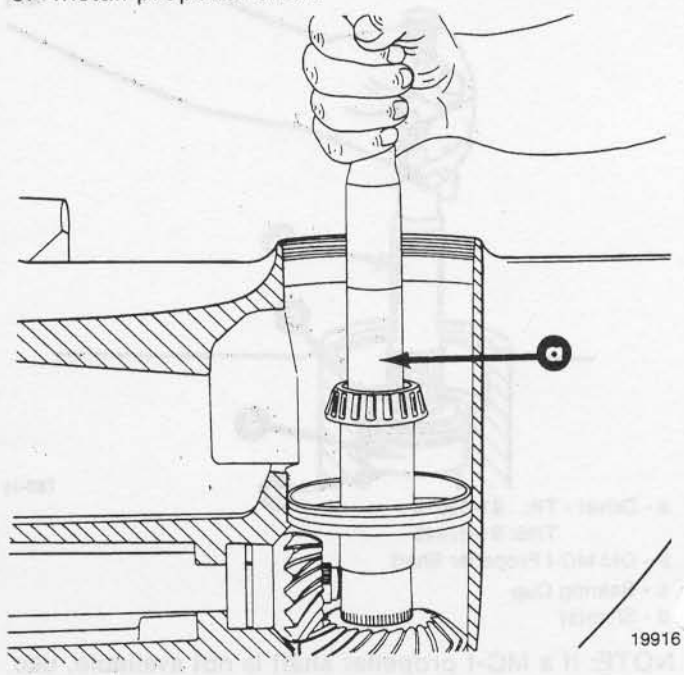
c. While holding down on drive shaft, measure clearance between tool and gear with a feeler gauge. Clearance must be .025 in. (.635mm) Take measurement at 3 locations on gear (120° apart).

If clearance is less than specified, add appropriate thickness shim(s) under drive shaft tapered roller bearing cup.

If clearance is more than specified, remove appropriate thickness shim(s) under drive shaft tapered roller bearing cup.

d. Recheck clearance after changing shims.

5. Install propeller shaft.

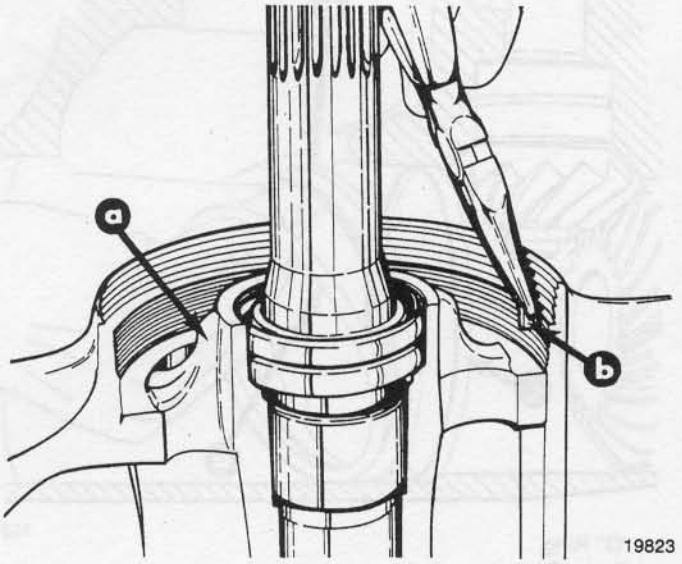


19916

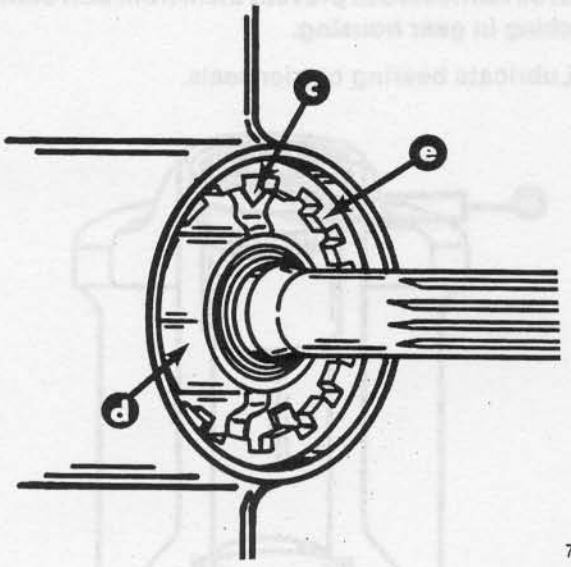
a - On Right Hand Rotation Units, Propeller Shaft Must Be Tilted Toward Top of Gear Housing to Install

6. Install bearing carrier.

NOTE: DO NOT install "O" ring until after shimming has been completed.



a - Bearing Carrier
b - Locating Key

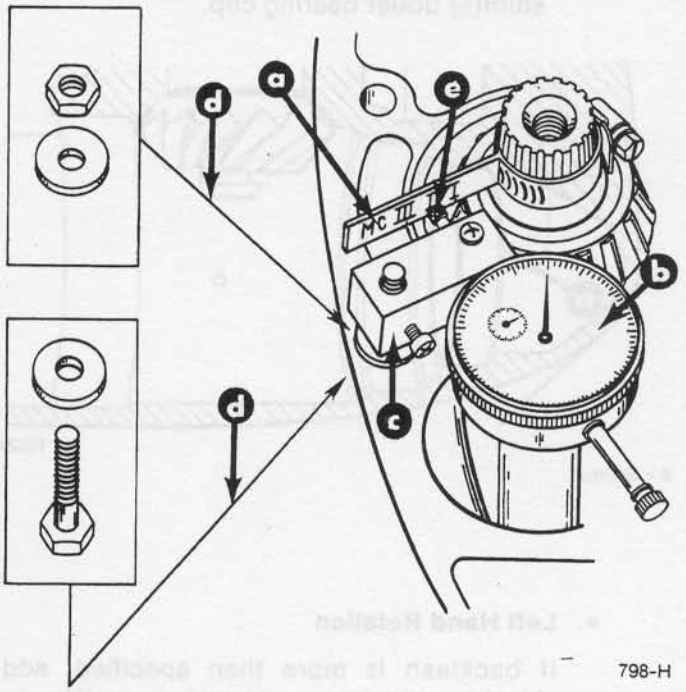


c - Tab Washer - "V" Notch in Recess in Carrier
d - Bearing Carrier
e - Threaded Retainer

7. Install and tighten threaded retainer until resistance to propeller shaft rotation can be felt (to preload bearings).

8. Driven gear shimming.

   a. Assemble shimming tools.



a - Indicator Rod, 91-53549
b - Dial Indicator, 91-58222A1
c - Holding Tool, 91-89897
d - 1/4 In. Screw, Washer and Nut
e - Dial Indicator Must Be At a Right Angle to Rod and Aligned with Proper Mark
TR - "II"
TRS - "III"

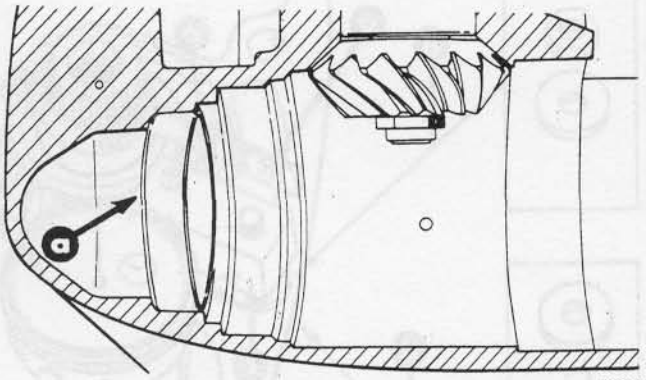
   b. Push down on drive shaft and check gear backlash by lightly rotating drive shaft back-and-forth. DO NOT allow propeller shaft to turn.

TR	.011 - .015 In. (0.28 - 0.38mm)
TRS	.009 - .013 In. (0.23 - 0.33mm)

c. If backlash is not correct, proceed as follows:

- **Right Hand Rotation**

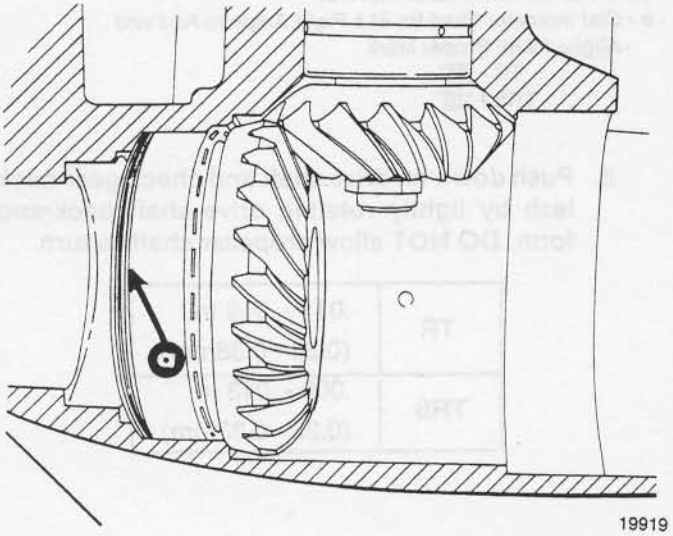
  If backlash is more than specified, remove shim(s) under propeller shaft front bearing cup. If backlash is less than specified, add shim(s) under bearing cup.



a - Shims

- **Left Hand Rotation**

  If backlash is more than specified, add shim(s) under drive gear bearing cup. If backlash is less than specified, remove shim(s) under bearing cup.

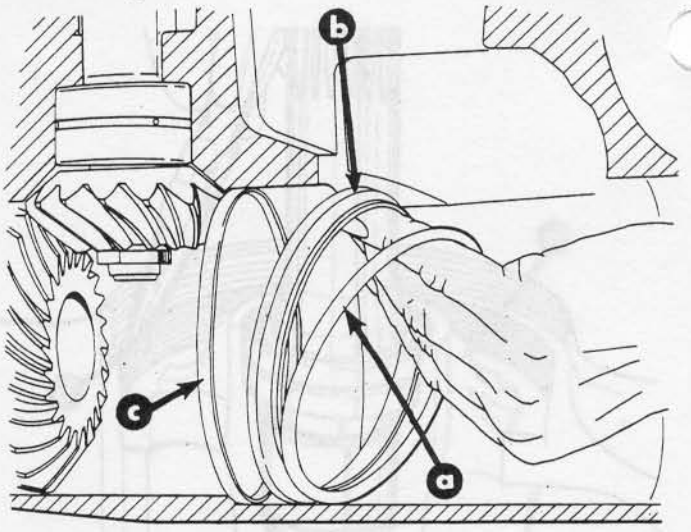


a - Shims

d. Recheck shimming after reassembly.

9. Remove bearing carrier and install items shown.

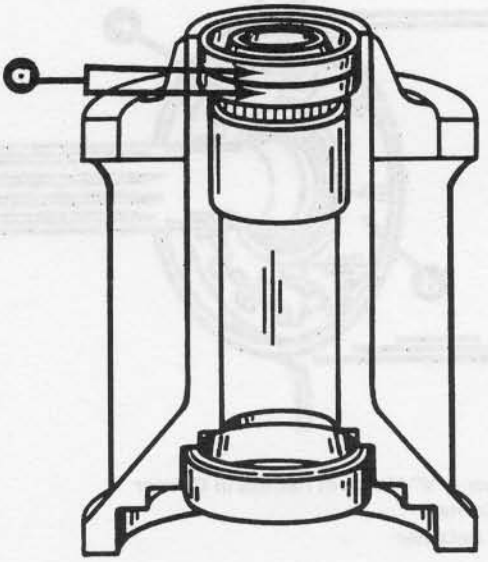
IMPORTANT: Always use a new load ring when reassembling.



a - "O" Ring
b - Thrust Ring
c - Load Ring

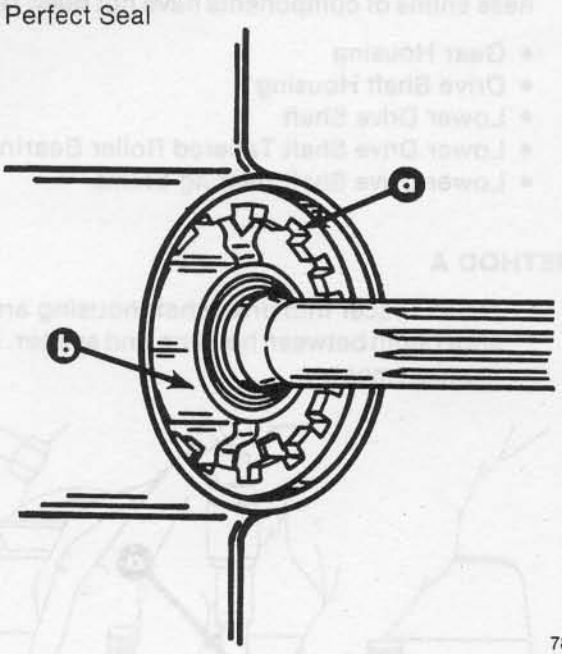
IMPORTANT: Bearing carrier and threaded retainer must be lubricated to prevent them from corroding and cracking in gear housing.

10. Lubricate bearing carrier seals.



a - Fill Space Between Seals with 2-4-C Multi-Lube

11. Lubricate components shown with one of the following products (listed in order of effectiveness):
    - Special Lubricant 101
    - 2-4-C Multi-Lube
    - Perfect Seal

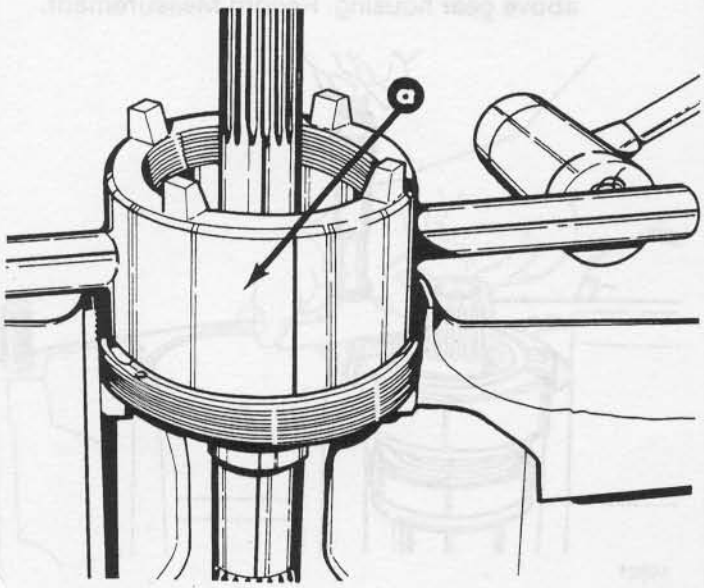


788-H

a - Lubricate Retainer Threads
b - Lubricate Outside Diameter of Bearing Carrier

12. Reinstall:
    - Bearing Carrier
    - Locating Key
    - Tab Washer
    - Threaded Retainer

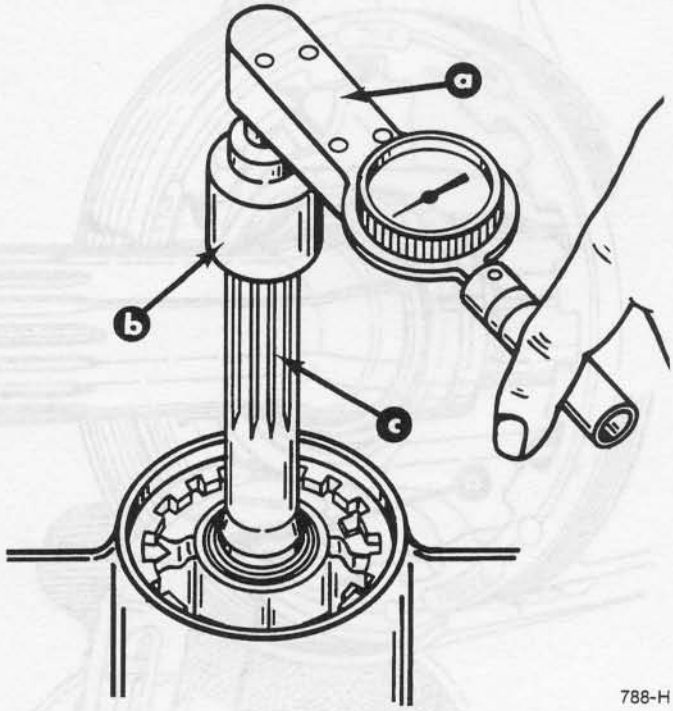
13. Propeller Shaft Bearing Preload.
    a. Tighten retainer in small increments.



19836

a - TR Retainer Tool 91-54873
TRS Retainer Tool 91-61069

b. After each tightening sequence, check propeller shaft bearing preload.



788-H

a - In. Lbs. Torque Wrench 91-66274
b - Propeller Nut
c - Rotate Shaft in Direction of Normal Rotation Using a Smooth, Steady Motion

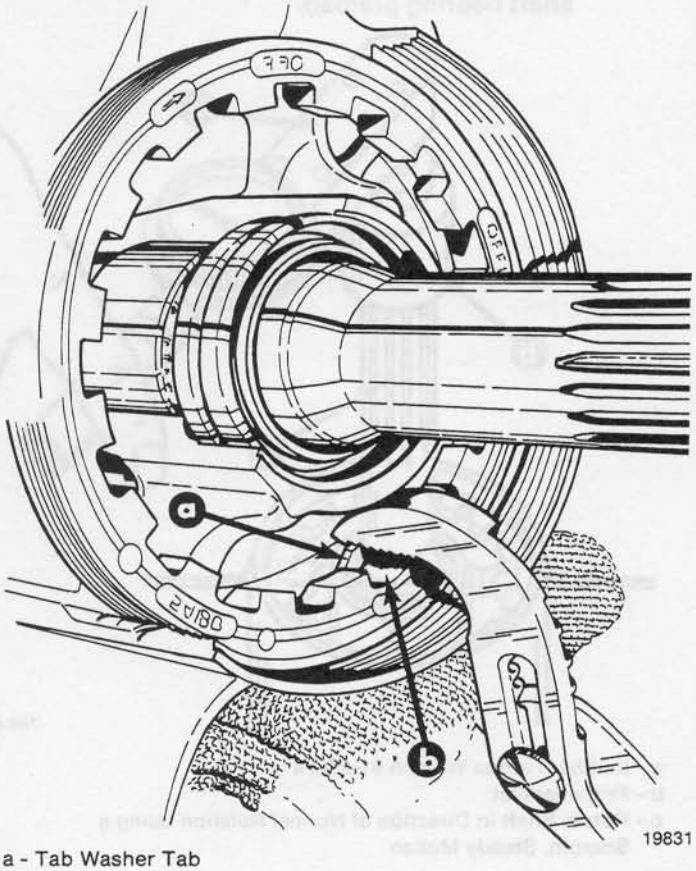
c. Continue tightening retainer until specified preload is attained.

Bearing Preload (TR & TRS)	
New Bearings	8 - 15 Lbs. In.
*Used Bearings	3 - 6 Lbs. In.

*Bearing is considered used if spun under load even once.

d. Record reading for later use.

14. Bend tab on tab washer.

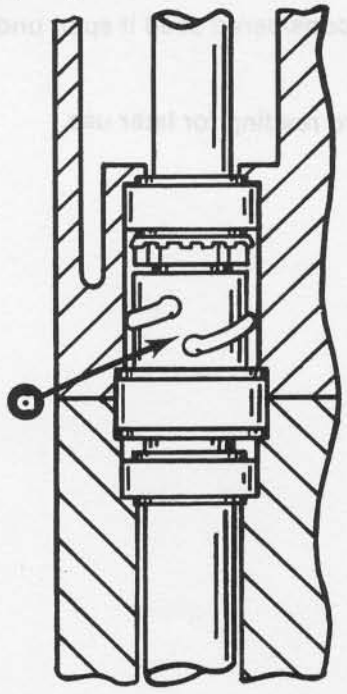


19831

a - Tab Washer Tab
b - Groove in Retainer

Gear Housing to Drive Shaft Housing Reassembly

1. Determine "Lower Drive Shaft Bearing Preload", using chart in "Specifications".
2. Install coupling in drive shaft housing.



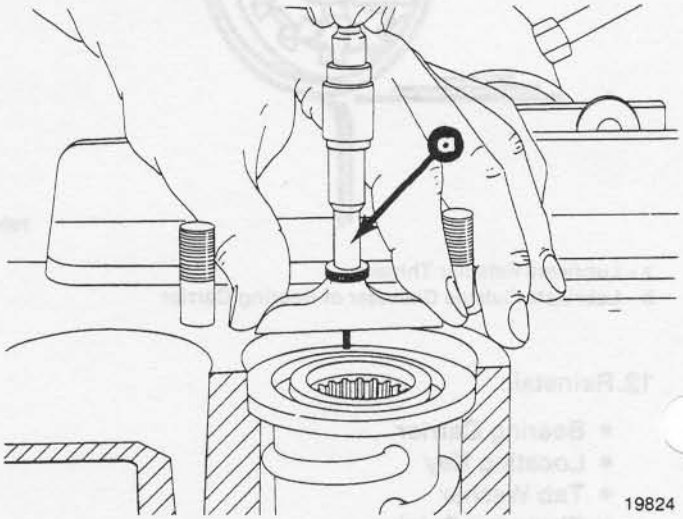
a - Coupling

788-H

3. If components listed below have been replaced, use Method A or B, following, to determine shim thickness required between drive shaft housing and lower drive shaft upper bearing. Use original thickness shims of components have not been replaced.
   - Gear Housing
   - Drive Shaft Housing
   - Lower Drive Shaft
   - Lower Drive Shaft Tapered Roller Bearings
   - Lower Drive Shaft Bearing Shims

METHOD A

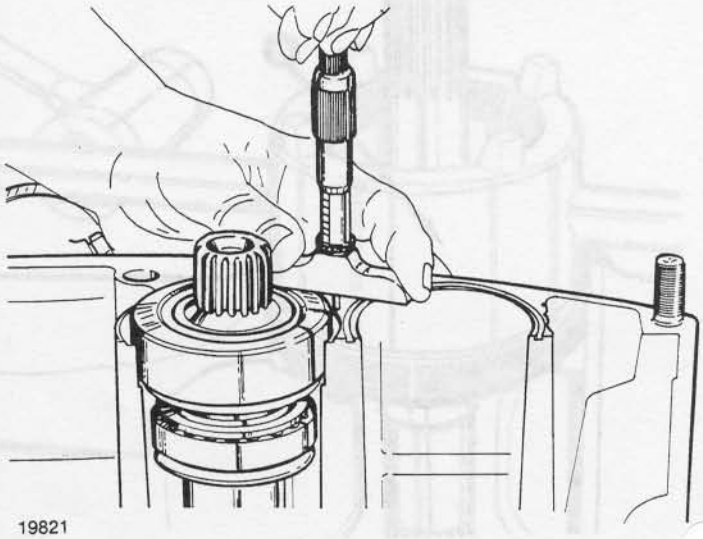
a. Insert spacer into drive shaft housing and measure depth between housing and spacer. Record measurement.



19824

a - 0 In. - 1 In. Depth Micrometer

b. Measure height that upper bearing protrudes above gear housing. Record Measurement.



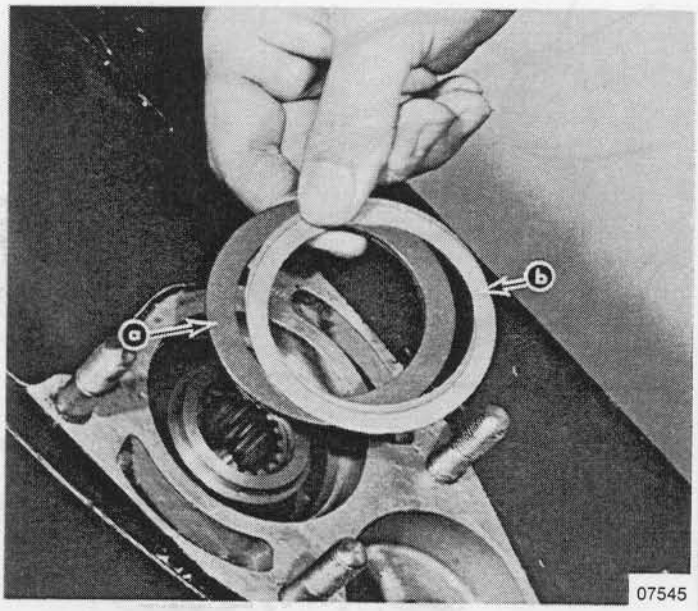
19821

c. Calculate shim thickness as shown.

Measurement "a" - Measurement "b" + .002 In. = Shim Thickness Required

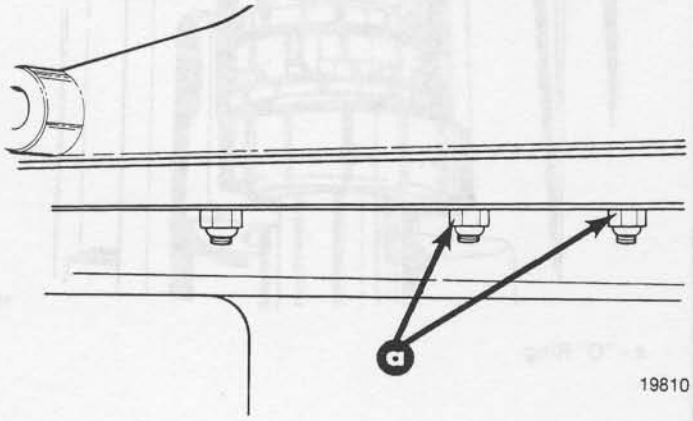
METHOD B

a. Install spacer, .060 In. worth of shims in drive shaft housing and bearing cup.



a - Spacer
b - .060 In. Shims

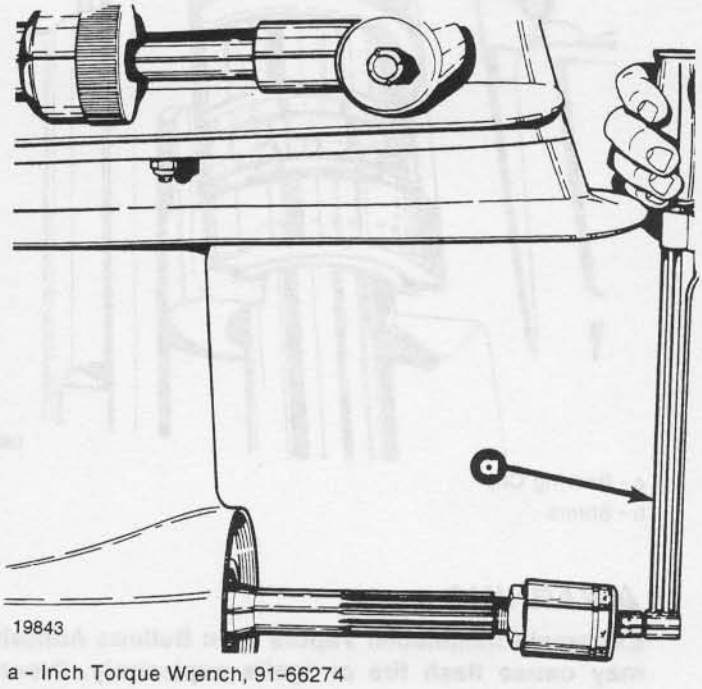
b. Assemble gear housing to drive shaft housing. Install 4 attaching nuts, but do not tighten.



a - Nuts

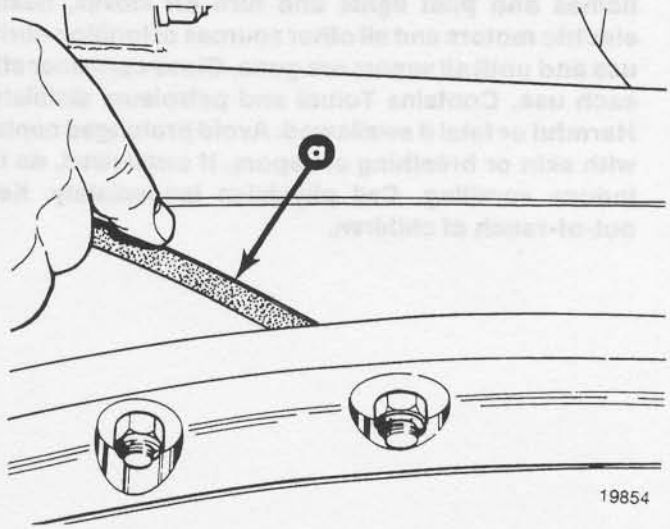
c. Position stern drive unit so that U-joint assembly hangs straight down.

d. Tighten 4 housing attaching nuts evenly (to maintain an even gap between housings) until specified "Lower Drive Shaft Bearing Preload" is obtained when measured at propeller shaft. Take reading in direction of normal propeller rotation.



a - Inch Torque Wrench, 91-66274

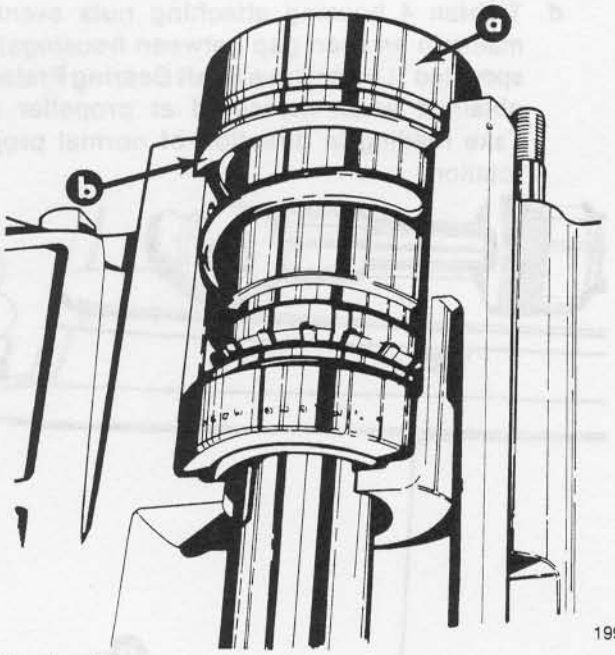
e. Measure gap between housings on both sides and take the average of two readings.



a - Feeler Gauge

f. Separate housings and remove shims (equal in thickness to measurement obtained) from upper bearing.

4. Install bearing cup with appropriate thickness shims.



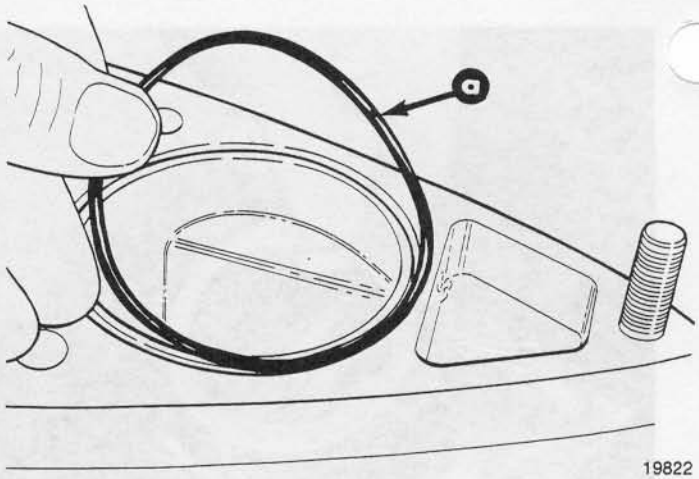
19931

a - Bearing Cup
b - Shims

⚠WARNING

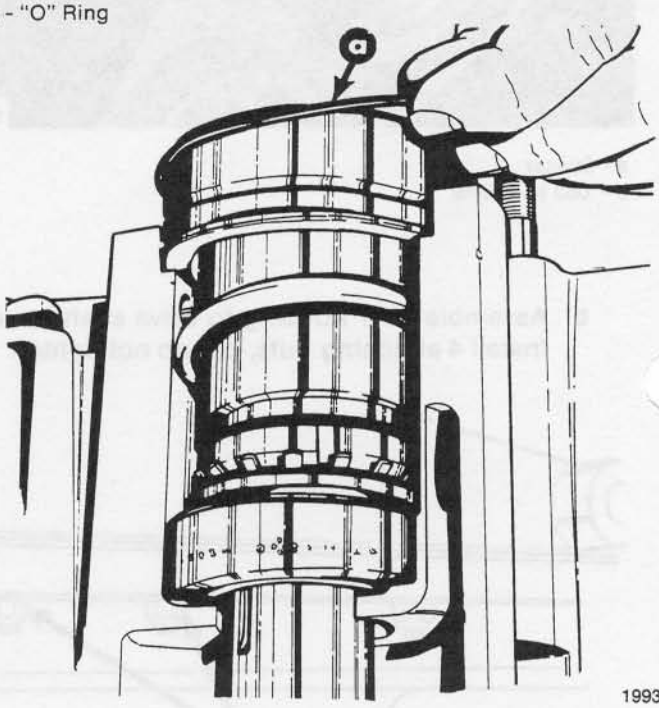
Extremely flammable! Vapors from Bellows Adhesive may cause flash fire or ignite explosively. Prevent buildup of vapors. Open all windows and doors. Use only in cross-ventilation. Keep away from heat, sparks and open flame. DO NOT SMOKE. Extinguish all flames and pilot lights and turn off stoves, heater, electric motors and all other sources of ignition during use and until all vapors are gone. Close container after each use. Contains Toluol and petroleum distillates. Harmful or fatal if swallowed. Avoid prolonged contact with skin or breathing of vapors. If swallowed, do not induce vomiting. Call physician immediately. Keep out-of-reach of children.

5. Install items shown. Use Bellows Adhesive or Adhesive Glue to retain "O" rings.



19822

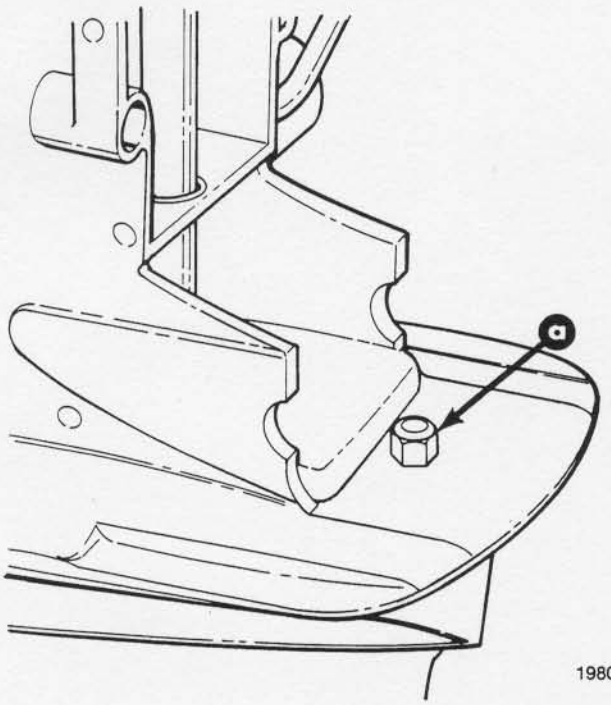
a - "O" Ring

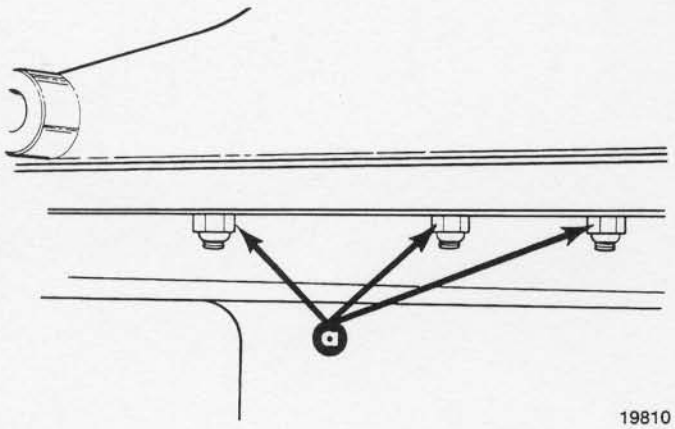


19932

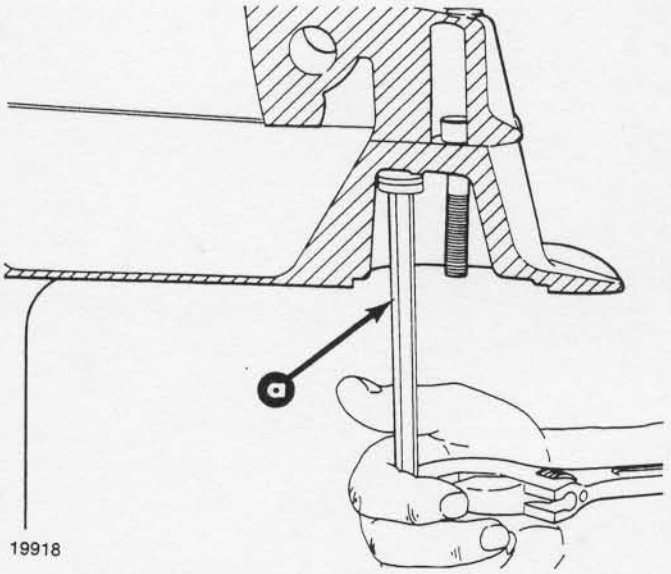
a - "O" Ring

6. Assemble gear housing to drive shaft housing.



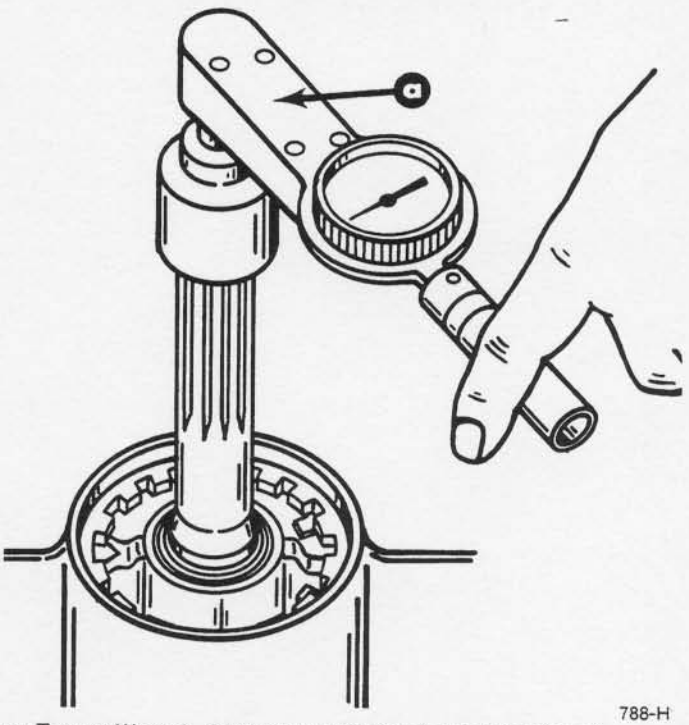


a - Tighten 6 Nuts Securely [35 Lbs. Ft. (47 N.m)]



a - Tighten Screw Securely [50 Lbs. Ft. (68 N.m)]

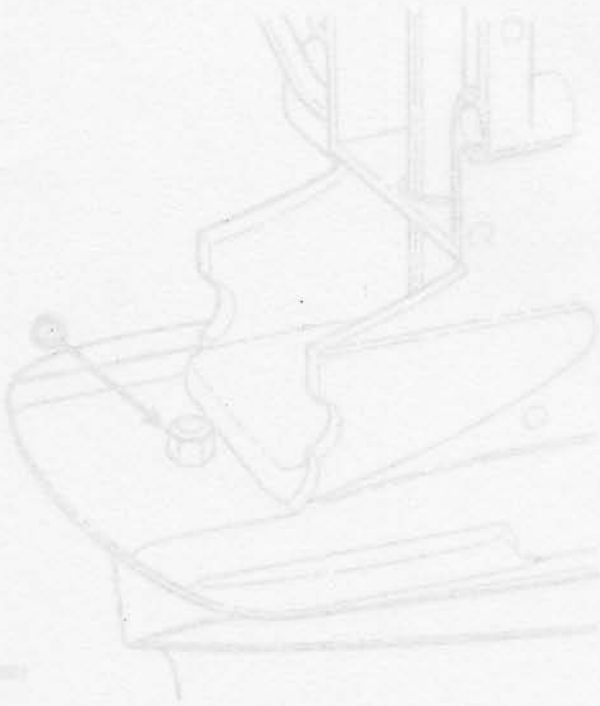
7. Check "Lower Drive Shaft Bearing Preload".
   a. Position stern drive unit so that U-joint assembly hangs straight down.
   b. Measure preload at propeller shaft and compare with specification from Step 1.

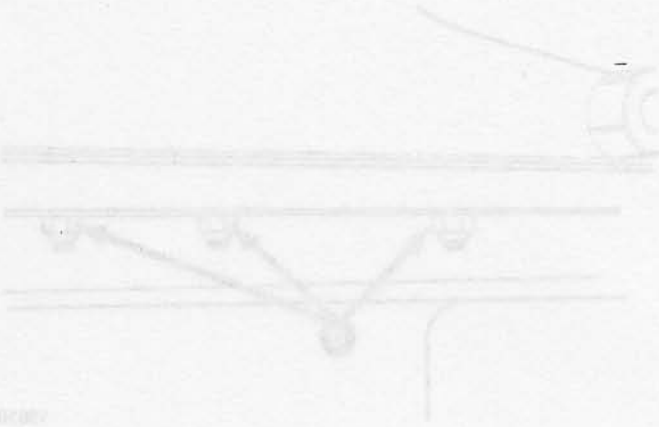


a - Torque Wrench, 91-66274 (Take Reading in Direction of Normal Rotation)

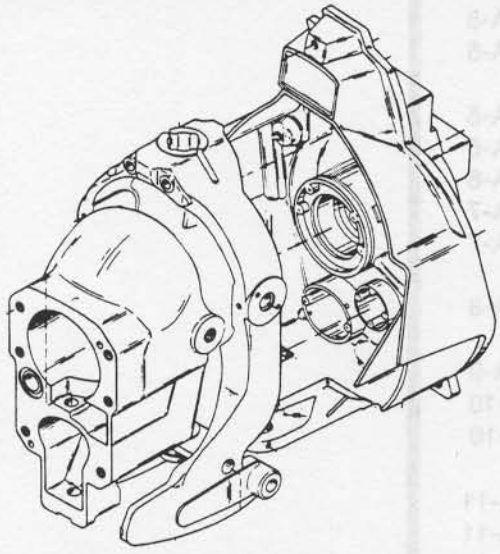
- **If low,** add shims to lower drive shaft upper bearing.
- **If high,** remove shims from lower driveshaft upper bearing.

8. Install trim tab (outlined preceding).
9. Install propeller.
10. Install stern drive unit and fill with lubricant.





TRANSOM ASSEMBLY



4

A

ALL MODELS

mercruiser
STERN DRIVES & INBOARDS

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Specifications

Gimbal Ring to Gimbal Housing Clearance
.005 - .007 In. (.127 - .178mm)

Torques

Clamping Screw, Steering Lever (All)	55-60 Lbs. Ft. (75-81 N.m)
Plug, Spline-Spline Swivel Shaft	40-45 Lbs. Ft. (54-61 N.m)
Thru Bolts, Square Connection Gimbal Ring	*25 Lbs. Ft. (34 N.m)
U-Bolt Nuts, Square Connection Gimbal Ring	Δ40 Lbs. Ft. (54 N.m)

*Torque in 3 Progressive Steps

ΔTorque in 4 Progressive Steps

NOTE: Tighten all fasteners which are not listed Securely.

Special Tools

Part Number	Description
91-55924	Driver
91-78310	Hinge Pin Tool
91-38919	Puller Head
91-63616	Puller Head
91-34569A1	Slide Hammer Puller
91-86191A1	Tap and Hole Saw Kit

Lubricants, Adhesives and Sealers

Quicksilver

Description	Part No.
Anti-Corrosion Grease	92-78376-12
Bellows Adhesive	92-86166
2-4-C Marine-Lube	92-90018A2
Perfect Seal	92-34227
Loctite "A"	92-32609-1
Loctite No. 35	92-59328-1
Loctite Primer "T"	92-59327-1
Special Lubricant 101	92-79214A1

Purchase Locally

Epoxy Glue

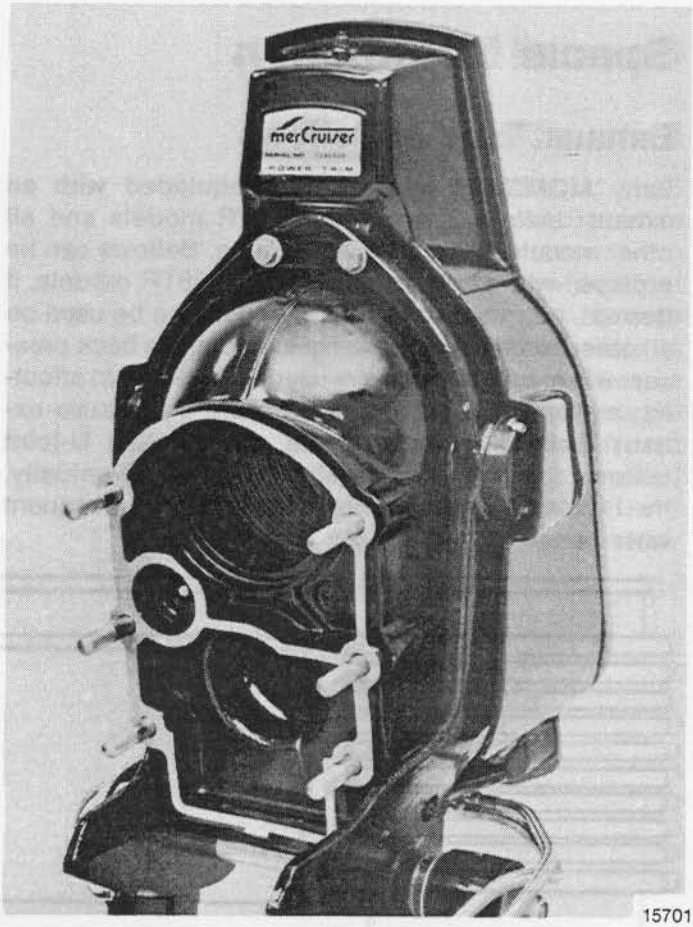
Description

The same transom assembly is utilized on both the TR and the TRS.

Transom assembly provides for the inter-connection of the stern drive unit to the engine and is rigidly mounted to the transom of the boat for ultimate strength. A gimbal arrangement is utilized to allow vertical and horizontal pivoting of the drive unit for steering, tilting and trimming. The gimbal is connected to the steering lever thru a solid connection (without gears) for optimum strength and tightness. The transom assembly incorporates a built in oil reservoir to allow the drive unit lubricant to be monitored from inside the boat.

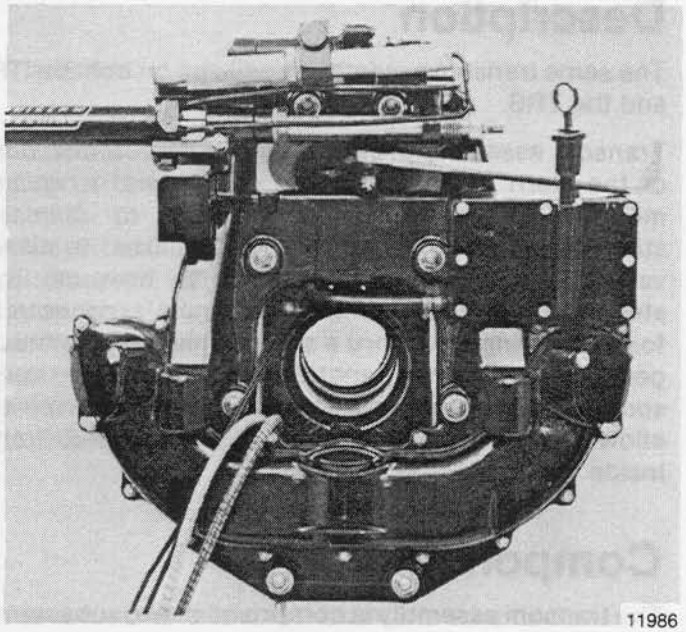
Component Parts

The transom assembly is comprised of two subassemblies: 1) the gimbal housing assembly and; 2) the inner transom plate assembly.



15701

Gimbal Housing Assembly

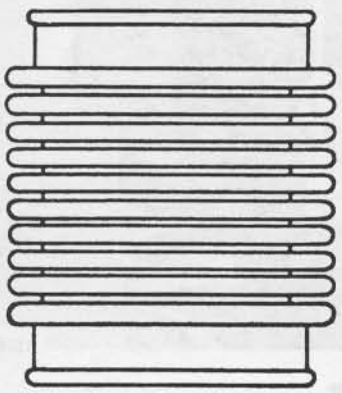


Inner Transom Plate Assembly

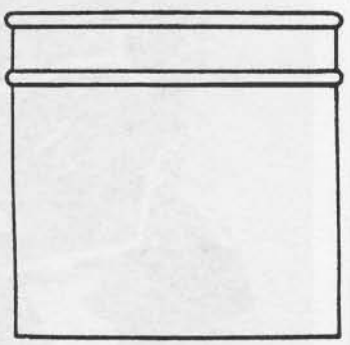
Special Information

Exhaust Tube or Bellows

Early MCM228TR models were equipped with an exhaust bellows. Later MCM228TR models and all other models utilize an exhaust tube. Bellows can be replaced with a tube on early MCM228TR models, if desired. It is mandatory that exhaust tube be used on all other models, as excessive exhaust gas back pressure will result if bellows are used. In addition to affecting performance, excessive pressure may cause exhaust bellows to balloon out and contact U-joint bellows, pushing them against U-joints. Eventually, the U-joint bellows may chafe thru with a subsequent water leak resulting.



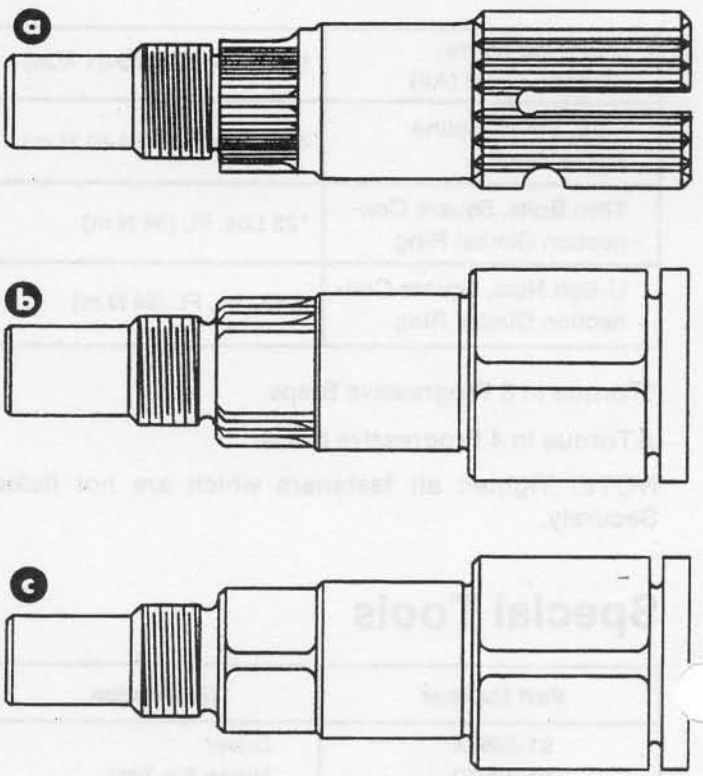
Exhaust Bellows, 54406



Exhaust Tube, 78632

Gimbal Ring/Swivel Shaft/Steering Lever Evolution

The following gimbal ring, swivel shaft and steering lever combinations have been used. It should be kept in mind, that the transom assembly serial number listed applies to the original equipment only. Older units may be refitted with the new components.



a - Spline-Spline
b - Square-Spline
c - Square-Square

Swivel Shaft Configurations

1.
a - Spline Connection Gimbal Ring
b - Spline-Spline Swivel Shaft 54404
c - Spline Connection Steering Lever 88433

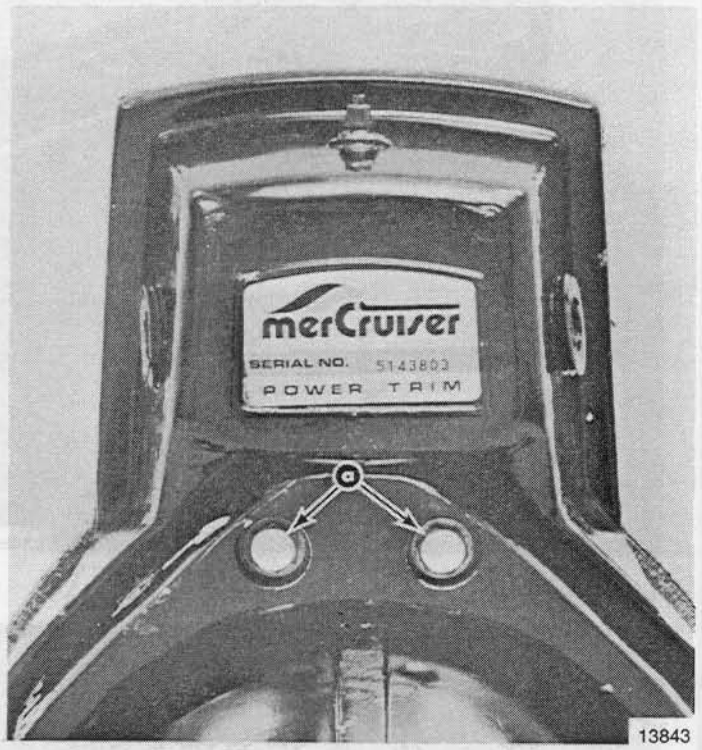
2.
a - Square Connection Gimbal Ring with Thru Bolts
b - Square-Spline Swivel Shaft 93305
c - Spline Connection Steering Lever 88433

3.
a - Square Connection Gimbal ring with U-Bolt
b - Square-Spline Swivel Shaft 93305
c - Spline Connection Steering Lever 88433

4.
a - Square Connection Gimbal Ring with Thru Bolts
b - Square-Square Swivel Shaft 44448
c - Square Connection Steering Lever 44447

Clamp Bracket Kit, 41456A1

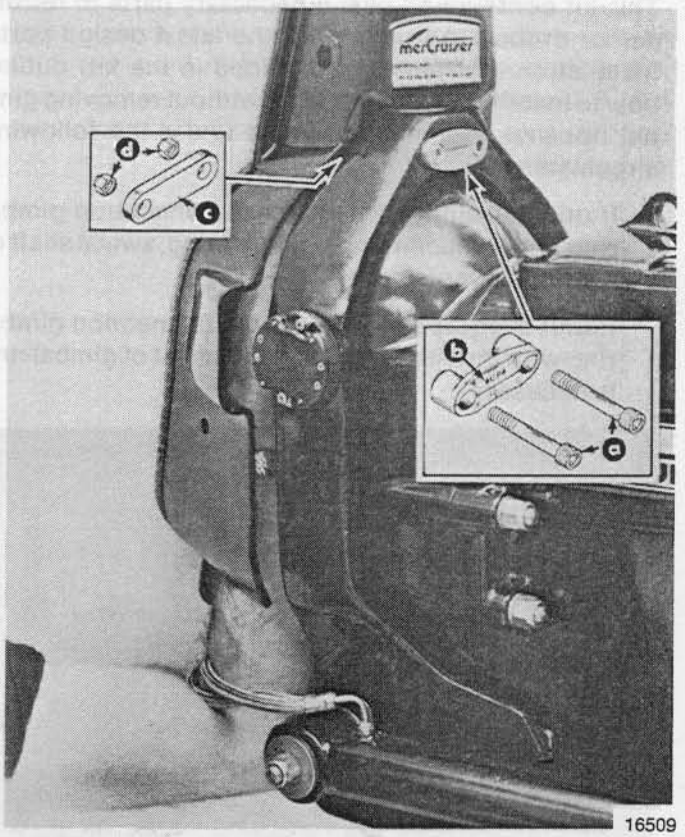
The potential exists for a crack to develop on the "Square Connection Gimbal Ring with Thru-Bolts". If this should occur it could cause loss of steering control.



13843

a - Thru Bolts

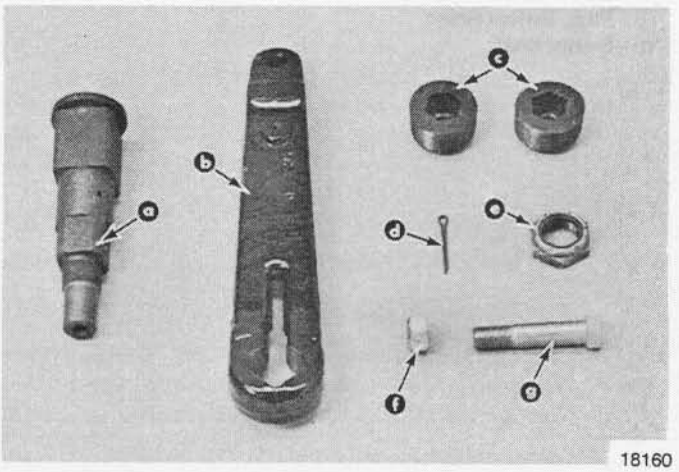
Clamp Bracket Kit, 41456A1 should be installed on any unit with this gimbal ring. Installation insturctions are provided with kit.



16509

Swivel Shaft/Steering Lever Kit 44448A1

This kit can be usd to convert units with square-spline swivel shaft and spline connection steering lever to the square-square swivel shaft and square connection steering lever. Kit can only be used on units with the square connection gimbal ring (thru-bolt or U-bolt design). All parts required to install new swivel shaft and steering lever (without removing gimbal housing) are included in kit, including installation instructions.



18160

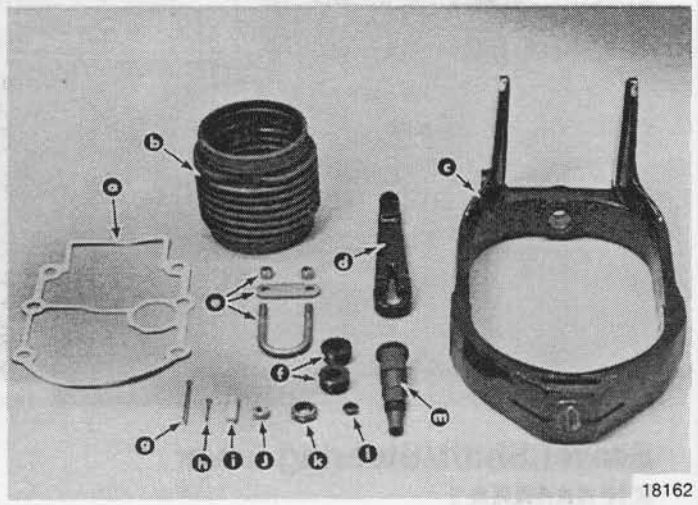
a - Swivel Shaft
b - Steering Lever
c - Plastic Plugs, Gimbal Housing
d - Cotter Pin, Steering Link Rod
e - Locknut, Swivel Shaft
f - Nut, Steering Lever
g - Screw, Steering Lever

Swivel Shaft/Steering Lever/Gimbal Ring Kit, 42385A7

This kit contains all of the necessary parts to retrofit earlier production units with the latest design parts. Installation instructions (provided in the kit) outline how to install new components without removing gimbal housing. Kit must be used under the following circumstances:

If unit is equipped with spline connection gimbal ring and replacement of gimbal ring, swivel shaft or steering lever is required.

If unit is equipped with square connection gimbal ring with thru-bolts, and replacement of gimbal ring is necessary.



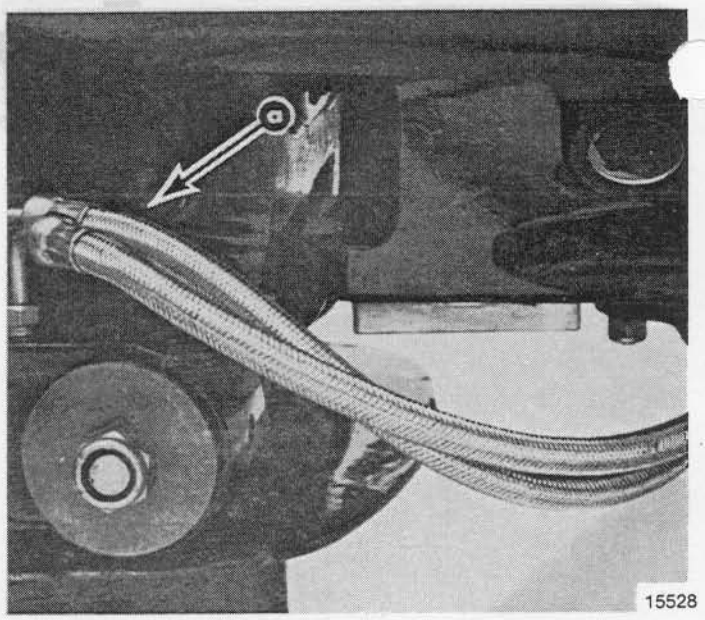
a - Gasket, Stern Drive Unit
b - U-Joint Bellows
c - Gimbal Ring
d - Steering Lever
e - U-Bolt Assembly
f - Plastic Plugs, Gimbal Housing
g - Cotter Pin, Swivel Pin
h - Cotter Pin, Steering Link Rod
i - Wooden Dowel
j - Nut, Steering Lever
k - Locknut, Swivel Shaft
l - Plug, Swivel Shaft
m - Swivel Shaft

Lubrication

IMPORTANT: Refer to Section 1-B for lubrication intervals.

Lubricate gimbal housing swivel shaft and pin with 2-4-C Marine-Lube. Be sure to reinstall protective caps.

a - Grease Fitting



a - Grease Fitting

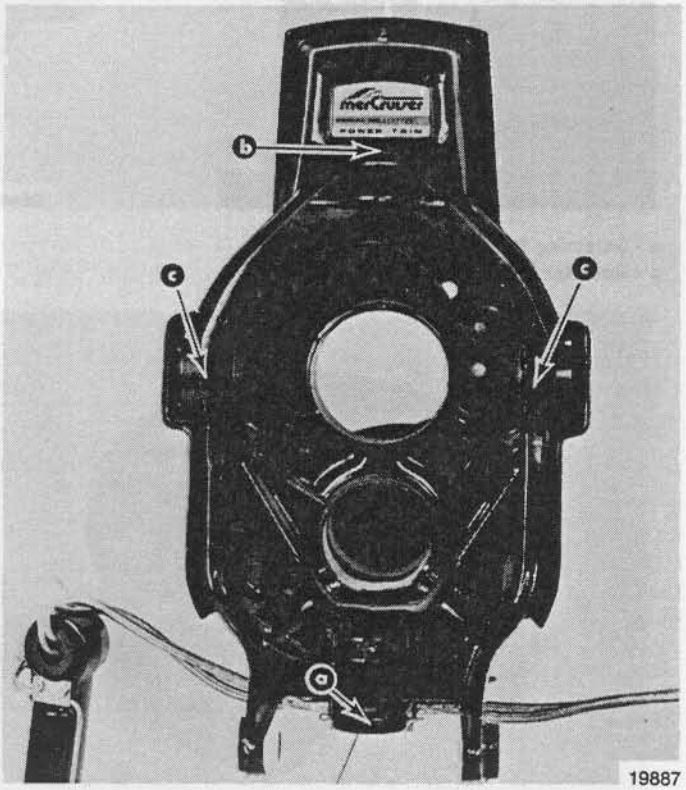
Impact Damage

If an underwater object is struck with the stern drive unit, the transom assembly should be carefully inspected for cracks or distortion paying particular attention to the following areas.

A. Bottom gimbal ring support on gimbal housing.

B. Gimbal housing around upper swivel shaft.

C. Area around hinge pins.



19887

Transom Assembly Removal/ Installation

Refer to Section 2.

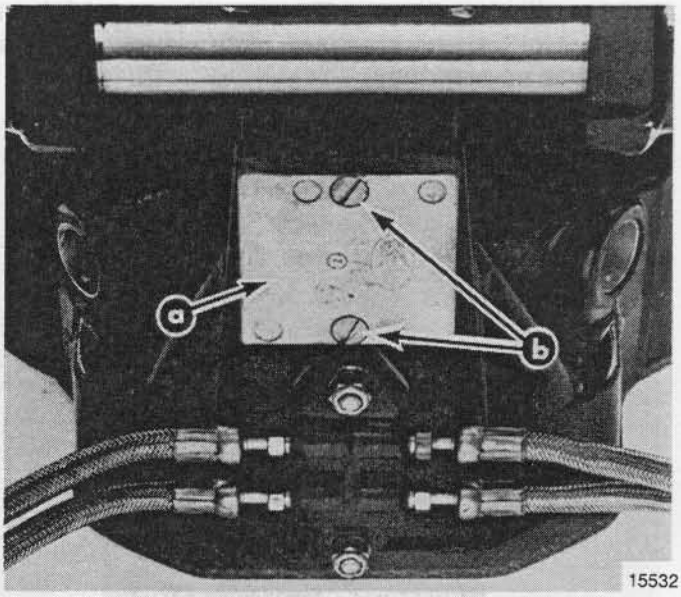
Gimbal Bearing Replacement

Transmission output bearing serves as the gimbal bearing. Refer to appropriate engine service manual for replacement procedure.

Anode Plate Replacement

Anode plate must be replaced when erosion reaches 50%.

1. Remove attaching screws and plate.



15532

a - Anodic Plate
b - Attaching Screws

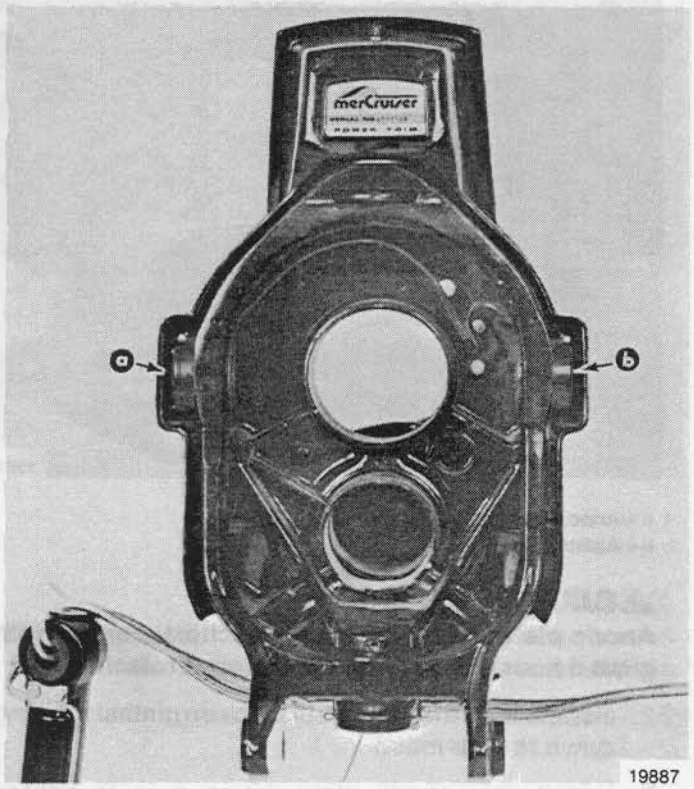
⚠CAUTION

Anode plate must make good electrical contact with gimbal housing to provide corrosion protection.

2. Scrape anode mounting surface on gimbal housing down to bare metal.
3. Install new anode plate, being sure to tighten screws securely.

Trim Limit Switch/Trim Position Sender Servicing

Trim limit switch and trim position sender are located and identified as shown. Trim position sender is an option. Unit comes standard with a dummy sender which has no markings.



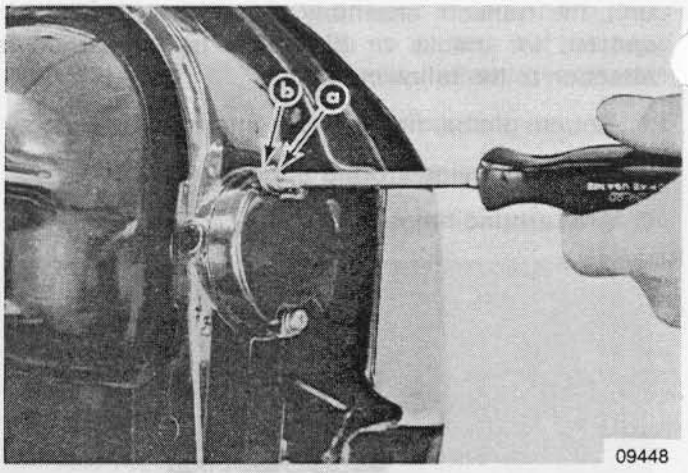
a - Trim Limit Switch (Marked "TL")
b - Trim Position Sender (Marked "TP")

Testing

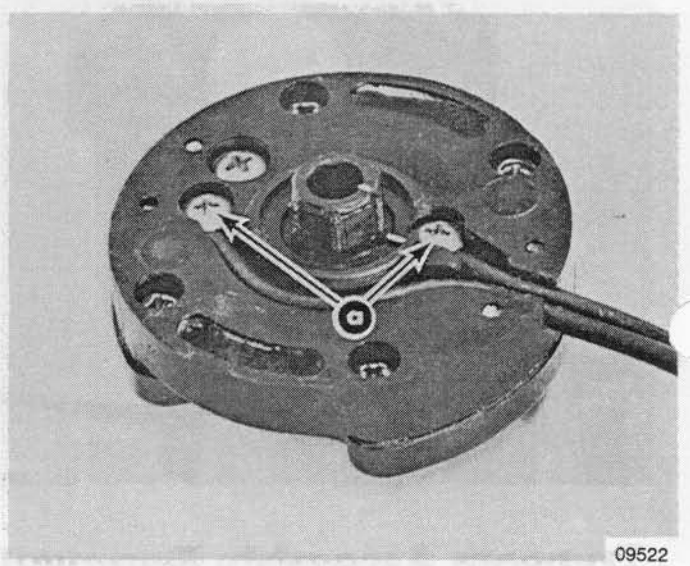
Refer to Section 5-A.

Replacement

1. Remove switch or sender as shown.



a - Retaining Screw and Lockwasher (2)
b - Retainer (2)



a - Trim Lead Attaching Screws

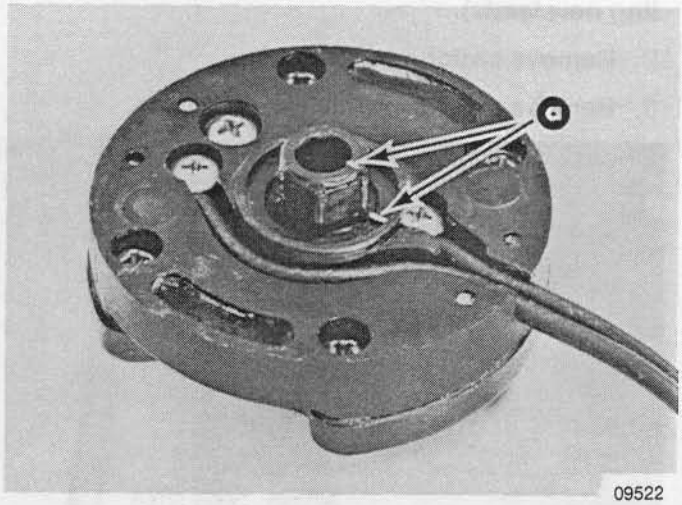
⚠CAUTION

If installing a trim position sender for the first time, be sure to use 5/32 in. (4mm) long screws provided with sender. Do not use longer screws from dummy sender as damage to sender will result.

2. Reattach leads to switch or sender as follows:
   A. Place a small amount of Anti-Corrosion Grease (or insulating compound provided with new switch or sender) in grooves in housing.
   B. Reconnect leads to housing.
   C. Fill remainder of grooves with Anti-Corrosion Grease to prevent corrosion.

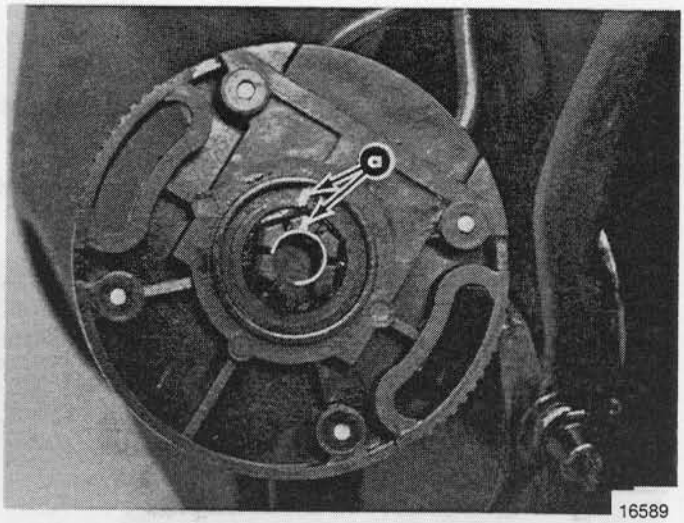
Trim Limit Switch Adjustment

1. Position rotor so that index marks align.



a - Index Marks Aligned

Old Style



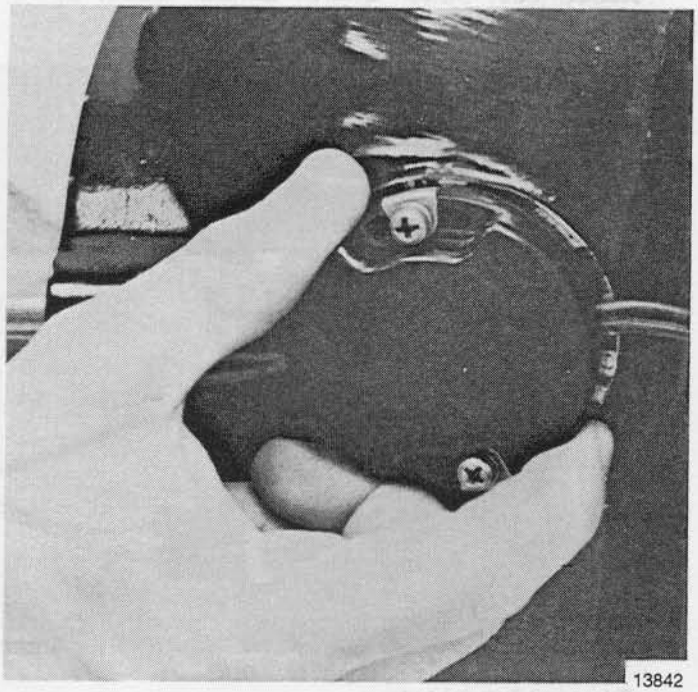
a - Index Marks Aligned

New Style

2. Place drive unit in the full "Down/In" position. Reinstall switch or sender, being sure to use indicator.
3. Adjust switch or sender as outlined following.

Trim Position Sender Adjustment

1. Place drive unit in the full "In/Down" position.
2. Loosen sender retaining screws.
3. Turn ignition switch to "Run" position.
4. Rotate sender until trim indicator needle is at the full "Down/In" mark.

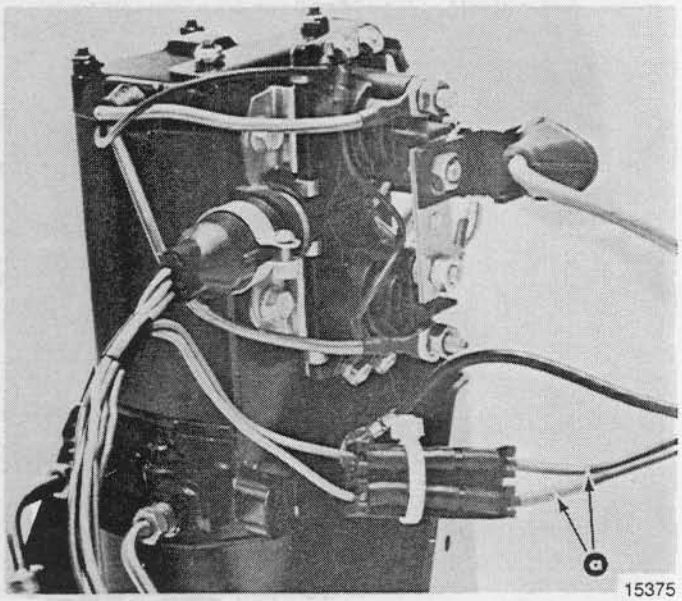


5. Tighten sender retaining screws securely.
6. Recheck indicator reading and turn ignition switch to "Off".

Trim Limit Switch/Trim Position Sender Leads Replacement

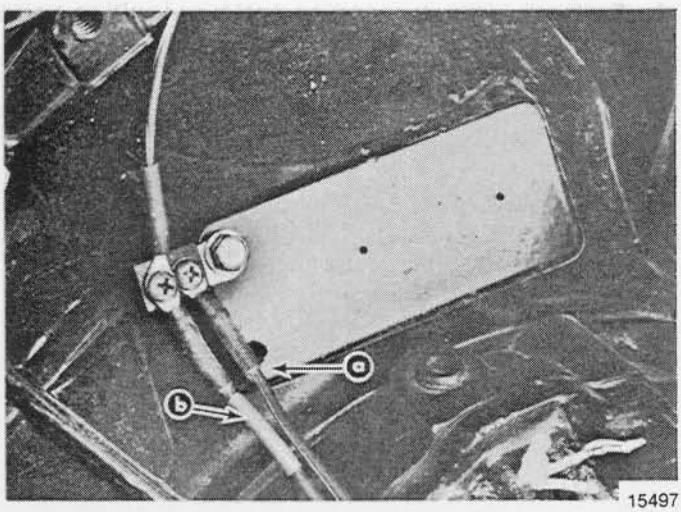
Leads can be replaced without disassembling transom assembly.

1. Disconnect switch and/or sender leads, as required, on inside of boat.



a - Trim Limit Switch Leads

Typical Model

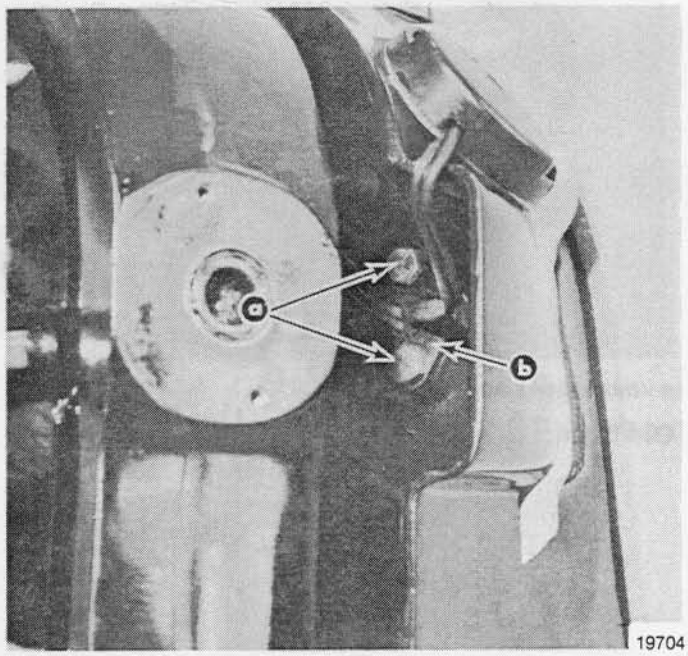


a - Trim Position Sender Leads
b - Purple Sleeved Lead Must Be Reconnected to Terminal with Engine Harness Lead Attachment

Typical Model

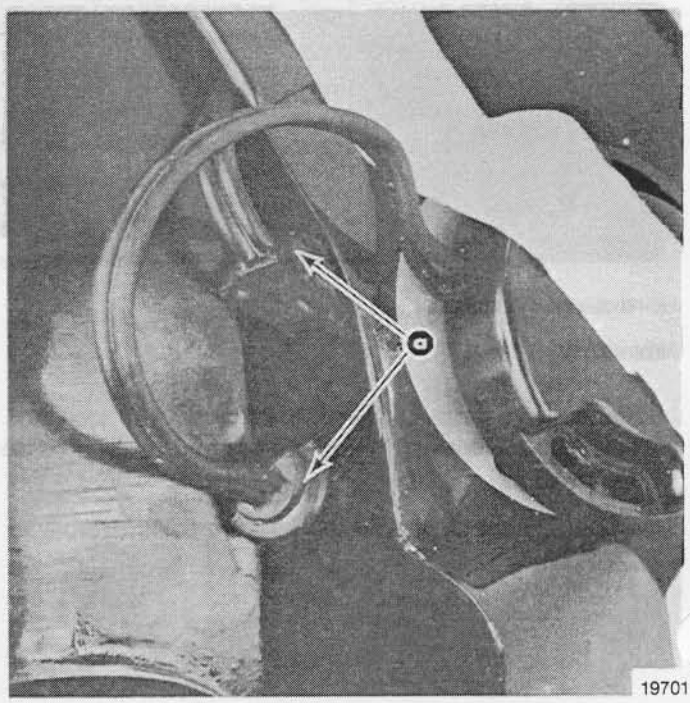
IMPORTANT: Tie a string or wire to leads before pulling them out off gimbal housing (for use when installing new leads).

2. Remove switch and/or sender.
3. Remove screws and trim lead retainer.



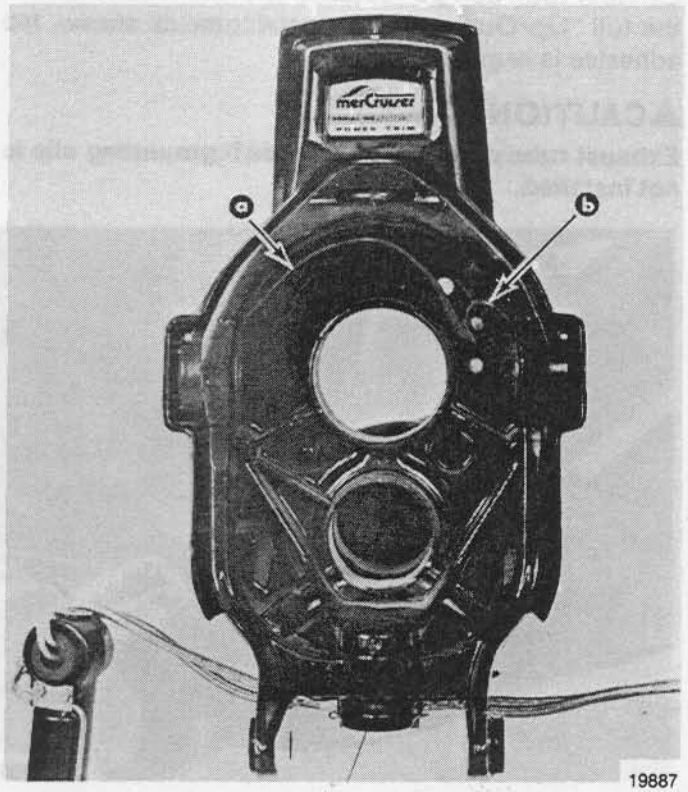
a - Screws
b - Trim Lead Retainer

4. Pull leads out of gimbal housing (from gimbal housing side).
5. Apply Perfect Seal to trim lead grommet halves and install leads.



a - Apply Perfect Seal to These Areas

6. Reinstall retainer and screws with Perfect Seal applied to threads. Tighten Securely.
7. Route leads as shown and reconnect switch and/or sender.



a - Trim Limit Switch Leads
b - Trim Position Sender Leads

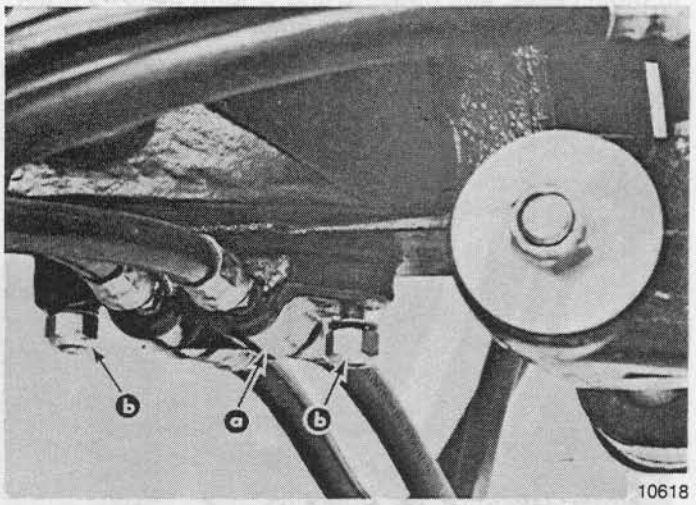
8. Reconnect trim leads on inside of boat, being sure to observe color coding.

Hydraulic Connector and Trim Pump Hose Replacement

1. Disconnect hose requiring replacement, from trim pump.

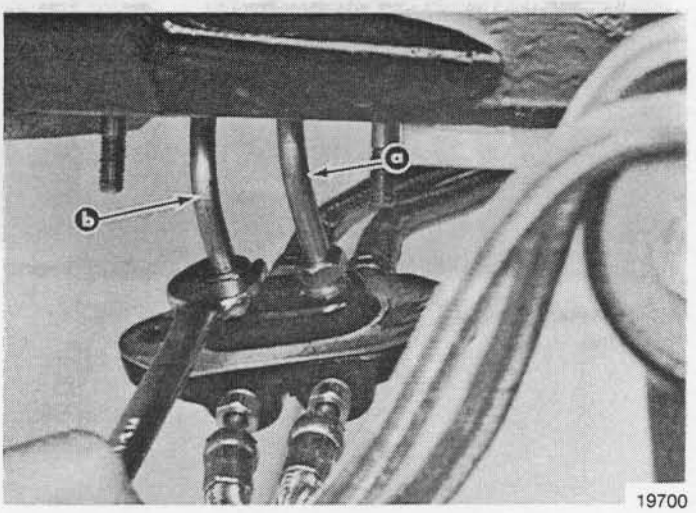
IMPORTANT: Tie a string or wire to hose before pulling it out of gimbal housing (for use when installing new hose).

2. Remove connector attaching nuts and lockwashers from base of gimbal housing.



a - Connector
b - Nuts

3. Pry connector loose from gimbal housing and disconnect hose to be replaced.



a - Gray Hose
b - Black Hose

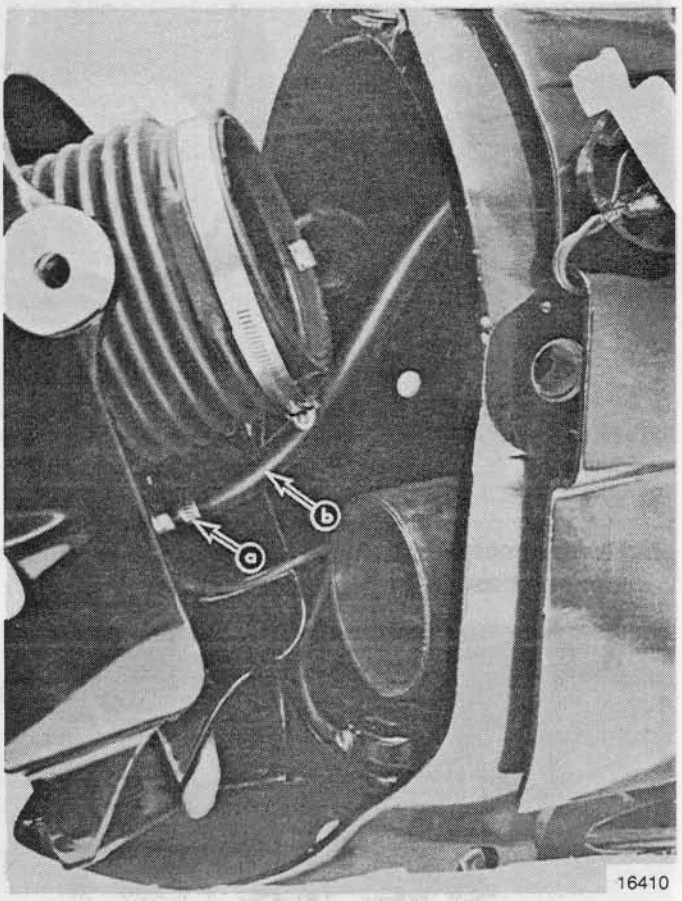
4. Pull old hose out of gimbal housing and install new hose.
5. Remove old gasket and clean surfaces of connector.

IMPORTANT: Apply Perfect Seal to fittings before installing hoses.

6. Place new gasket on connector and connect hose. Black hose must be connected to front connection.
7. Pull hoses back into and thru gimbal housing, reinstall connector. Torque nuts securely.
8. Reconnect hose to trim pump.

Oil Reservoir Hose Replacement

In most cases, bell housing and U-joint bellows must be removed to gain access to inner hose clamp.



a - Oil Reservoir Hose
b - Clamp

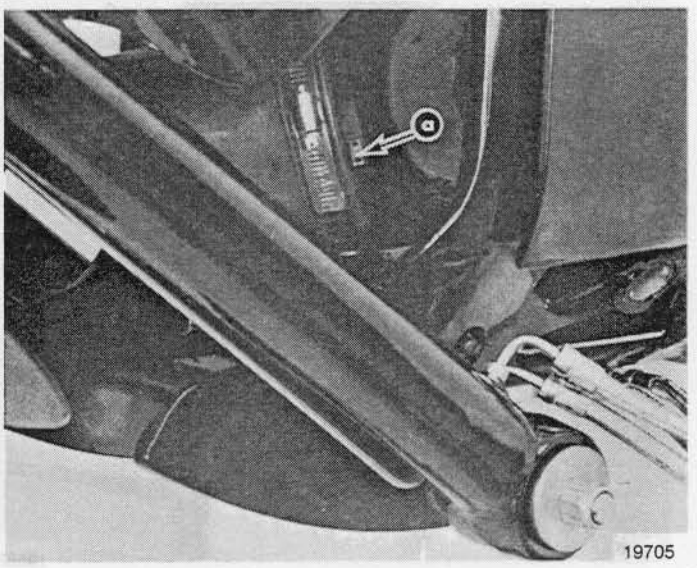
Exhaust Tube/Replacement

IMPORTANT: Refer to "Special Information", before proceeding.

Exhaust tube can be replaced with stern drive unit in the full "Up/Out" position. Install tube as shown. No adhesive is required.

⚠CAUTION

Exhaust tube clamp may corrode if grounding clip is not installed.



a - Install Grounding Clip Short Bend End With Two Bumps Inward, position as shown and tighten securely.

Bell Housing and U-Joint Bellows Servicing

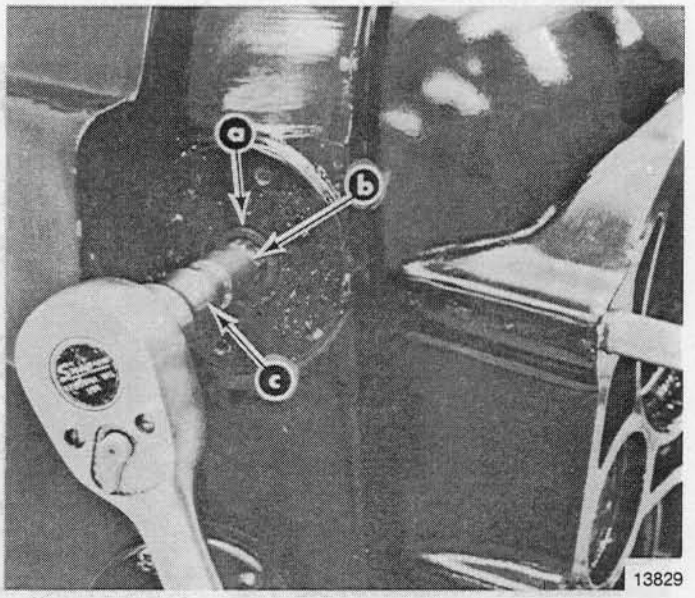
IMPORTANT: This procedure outlines servicing of units with exhaust tube. If unit has exhaust bellows, refer to "Exhaust Tube or Bellows Servicing" for removal and installation of bellows.

Removal

1. Remove stern drive unit. (Sec. 2)
2. Remove trim limit switch and trim position sender or dummy, as outlined preceding. Tape switch and sender to gimbal housing to prevent them from being damaged.

19710

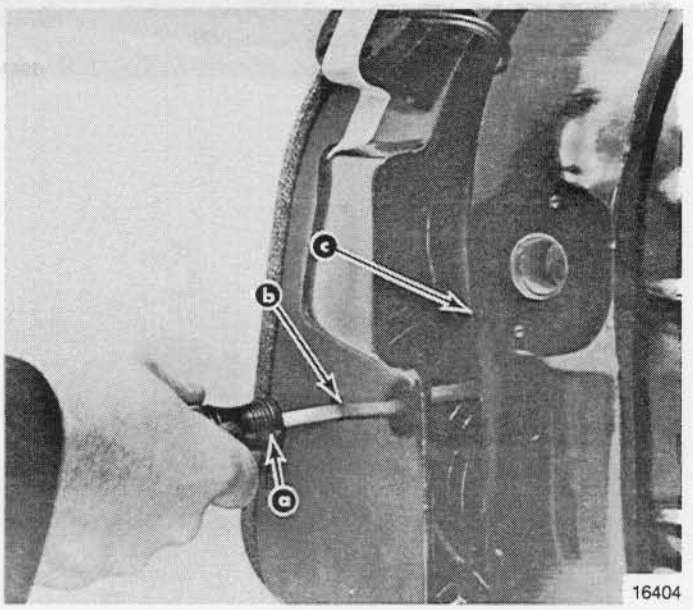
3. Remove hinge pins.



13829

a - Hinge Pin (1 Each Side)
b - Hinge Pin Tool, 91-78310
c - 1/2 In. Socket

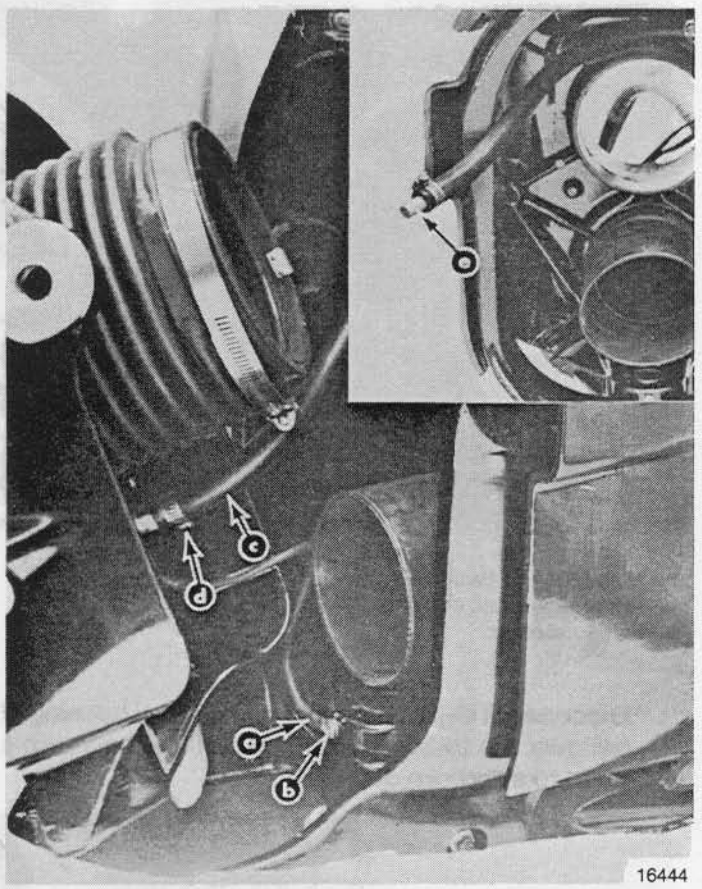
4. Disconnect U-joint bellows from gimbal housing. If bellows are to be replaced, cut off bellows with a knife to speed up disassembly.



16404

a - Screwdriver
b - Access Hole
c - U-Joint Bellows Clamp (Not Shown)

5. Disconnect ground wire and oil reservoir hose and remove bell housing. Plug hose to prevent oil leakage.



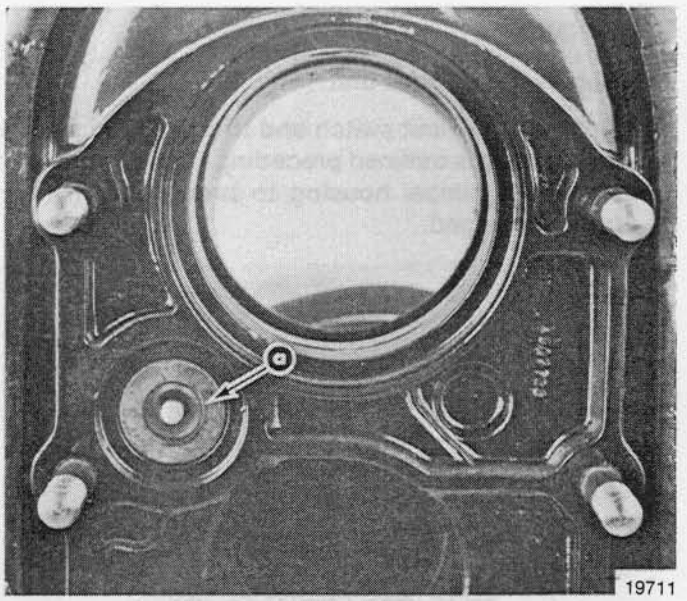
a - Ground Wire
b - Ground Wire Attaching Screw
c - Oil Reservoir Hose
d - Hose Clamp
e - Plug

Cleaning and Inspection

Refer to Basic Cleaning and Inspection (Sec. 1). Important points of attention are outlined following.

OIL PASSAGE SEAL

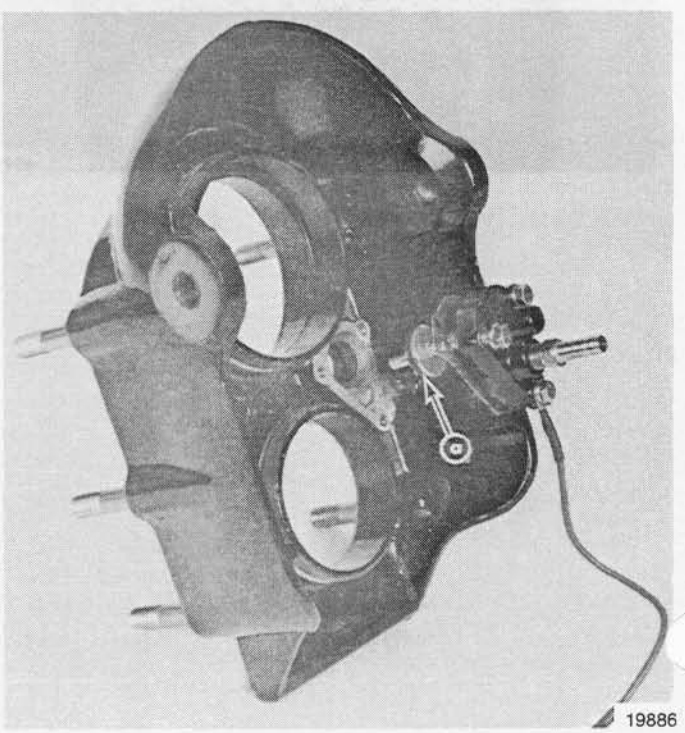
Inpsect seal lip for cuts, roughness or other damage. Seal casing should be inspected for corrosion damage.



a - Seal

OIL PASSAGE CHECK VALVE

If oil leaks from passage when drive unit is removed, remove check valve (as outlined following). Inspect sealing surface in bell housing for pitting or other damage. Replace quad ring.



a - Quad Ring

U-JOINT BELLOWS

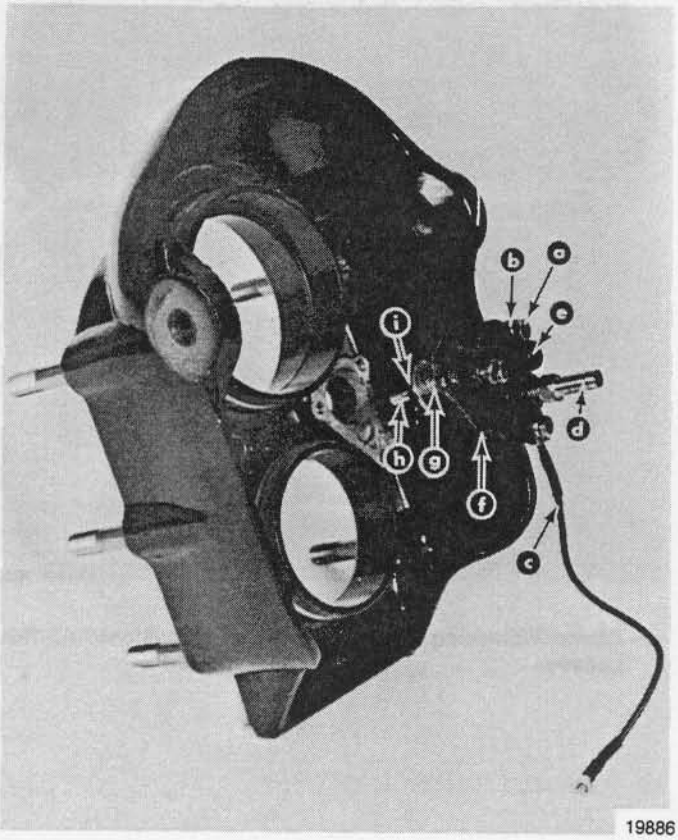
Inspect bellows for cracks, cuts, chafing damage and hardening. If condition is questionable, replace bellows.

Check to ensure that expander spring on inside of bellows is seated in convolutions. Spring must not be located in first convolution on forward end of bellows.

Component Replacement

OIL PASSAGE CHECK VALVE AND RELATED PARTS

Replace components as shown.

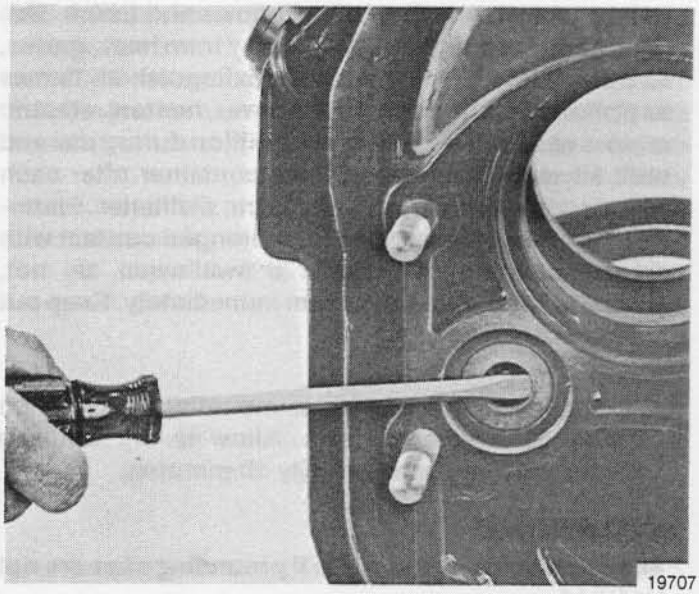


19886

a - Screw (3) (Tighten Securely)
b - Lockwasher (3)
c - Ground Wire
d - Connector (Coat Threads with Perfect Seal)
e - Cover
f - Gasket (Coat New with Perfect Seal)
g - Spring
h - Check Valve (Install with Chamfer Toward Bell Housing)
i - Quad Ring (Replace)

OIL PASSAGE SEAL

1. Remove oil seal as shown.



19707

2. Coat outer diameter of seal with Perfect Seal and install, using a suitable driver. Seal lip must face inward.

U-JOINT BELLOWS

Remove old bellows and install new bellows as outlined under "Installation".

BELL HOUSING STUDS

Install new studs with Loctite A applied to threads.

Installation

1. Clean the following:

   Threaded Holes In Bell Housing for Hinge Pins - Remove old Loctite, using a 5/8" - 18 tap.

   Hinge Pin Threads - Clean with a wire brush.

   U-Joint Bellows Mounting Surfaces (If Reused) - Remove old Bellows Adhesive with lacquer thinner and sandpaper.

   U-Joint Mounting Flange On Gimbal Housing and Bell Housing - Clean with lacquer thinner and sandpaper or a wire brush to remove old Bellows Adhesive and corrosion by-products.

IMPORTANT: If unit is equipped with exhaust bellows, also clean exhaust bellows mounting flange on bell housing and gimbal housing at this time.

⚠WARNING

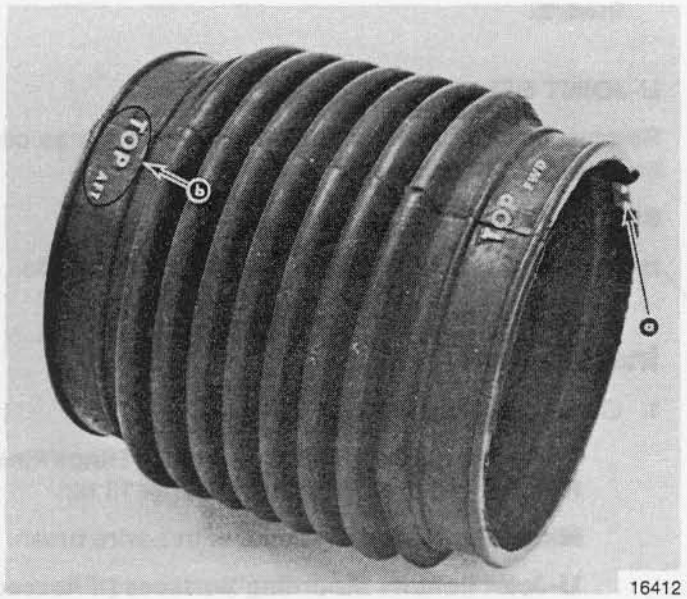
Extremely flammable! Vapors from Bellows Adhesive may cause flash fire or ignite explosively. Prevent build-up of vapors. Open all windows and doors. Use only in cross-ventilation. Keep away from heat, sparks, and open flame. Do not smoke. Extinguish all flames and pilot lights, and turn off all stoves, heaters, electric motors and all other sources of ignition during use and until all vapors are gone. Close container after each use. Contains Toluol and petroleum distillates. Harmful or fatal if swallowed. Avoid prolonged contact with skin or breathing of vapors. If swallowed, do not, induce vomiting. Call physician immediately. Keep out of reach of children.

2. Apply Bellows Adhesive to mounting surfaces on inside of U-joint bellows. Allow to dry until no longer tacky (approximately 10 minutes).

⚠WARNING

Bellows clamps may corrode if grounding clips are not installed.

3. Position grounding clips on bellows.



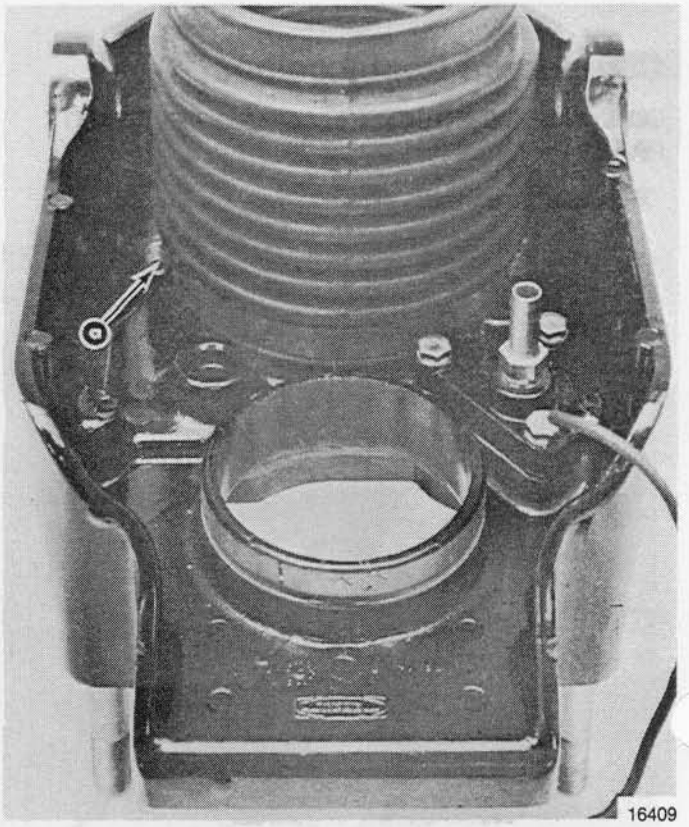
16412

a - Grounding Clips (2)
b - Bellows Must Be Installed with "Top Aft" Mark Toward Bell Housing and Upward.

⚠CAUTION

Bellows and clamps must be positioned correctly or chafing damage to bellows may result.

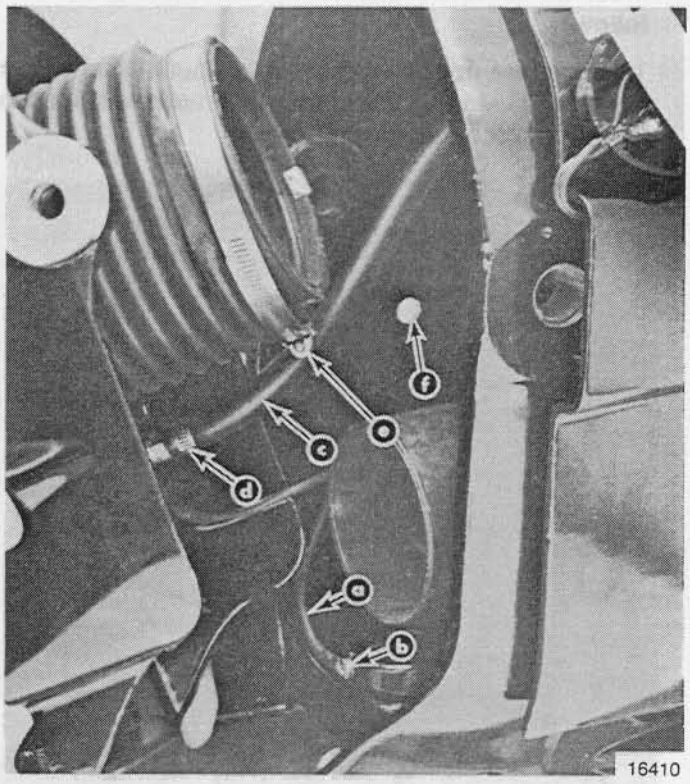
4. Install bellows to bell housing and tighten clamp securely as shown. Be sure that bead on inside of bellows fits into groove in bell housing flange.



16409

a - Clamp Tightening Mechanism Must Be Positioned At This Location

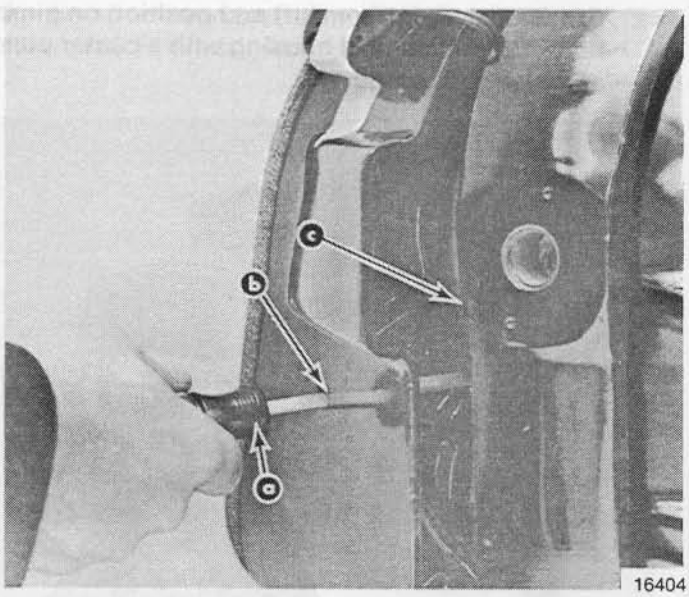
5. Reconnect ground wire and oil reservoir hose. Position clamp over bellows.



16410

a - Ground Wire
b - Ground Wire Attaching Screw
c - Oil Reservoir Hose
d - Clamp (Tighten Securely)
e - Clamp (Tighten Screw Must Be Pointed Toward Access Hose)
f - Access Hole

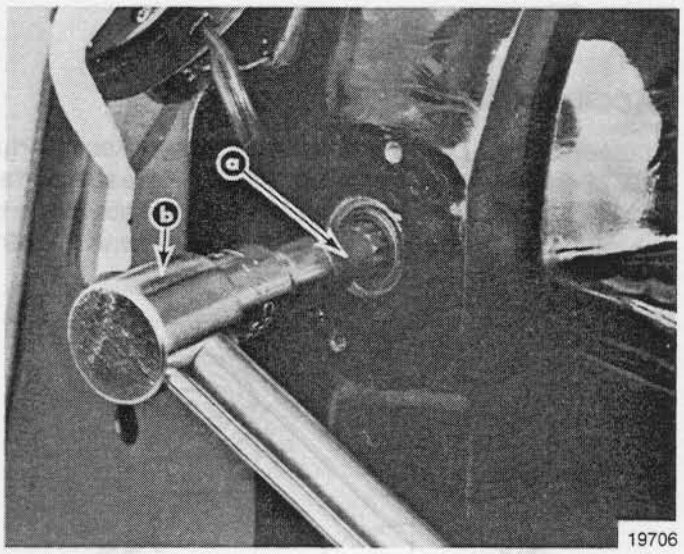
6. Connect bellows to gimbal housing and tighten clamp securely. Be sure that bead on inside of bellows fits into groove in gimbal housing flange.



16404

a - Screwdriver
b - Access Hole
c - Clamp (Not Shown)

7. Apply Loctite Primer "T" to threads of hinge pin and allow to dry; then, apply Loctite No. 35. Lubricate unthreaded area of hinge pins with 2-4-C Marine-Lube. Install pin and torque to 60 lbs. ft. (81 N.m).



19706

a - Hinge Pin Tool, 91-78310
b - Torque Wrench

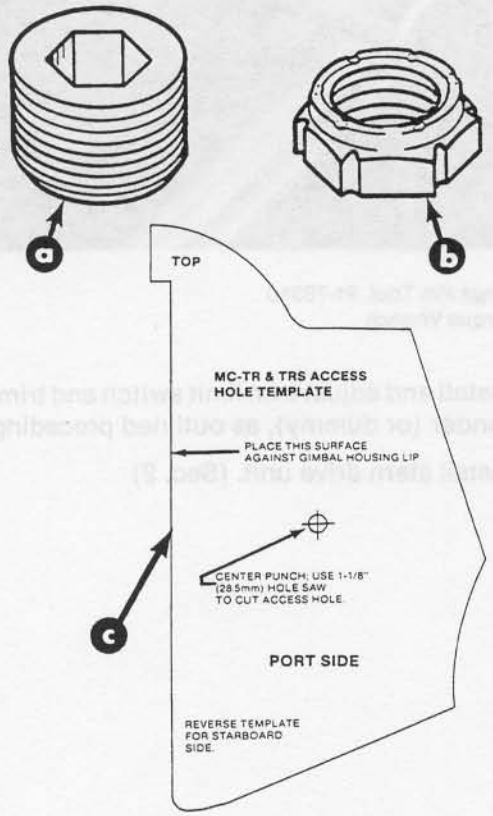
8. Install and adjust trim limit switch and trim position sender (or dummy), as outlined preceding.
9. Install stern drive unit. (Sec. 2)

Gimbal Ring/Swivel Shaft/ Steering Lever Servicing

IMPORTANT: Refer to "Special Information" before proceeding.

Access Plug Kit

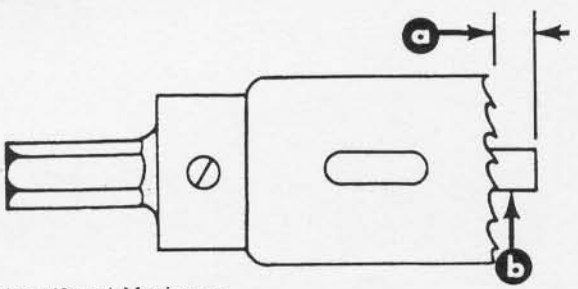
If steering lever cavity is not accessible, Access Plug Kit, 22-88847A1 is required, a 1-1/8 in. hole saw and a 1 in. NPT pipe tap also is required. These tools can be obtained by ordering Tap and Hole Saw Kit, 91-86191A1.



a - Access Plug, 22-88847 (2)
b - Swivel Shaft Nut, 11-88462
c - Template (Not to Scale)

Access Plug Kit, 22-88847A1

IMPORTANT: Hole saw must be fitted with a pilot rod in place of drill bit to prevent hole saw from wandering when cutting holes. Pilot rod must be installed so that it protrudes a maximum of 1/4" (6mm) from cutting teeth on hole saw.



a - 1/4 in. (6mm) Maximum
b - Pilot Rod

Refer to the removal procedure following and disassemble unit to the point where the subject fasteners must be removed and loosened, then proceed as follows:

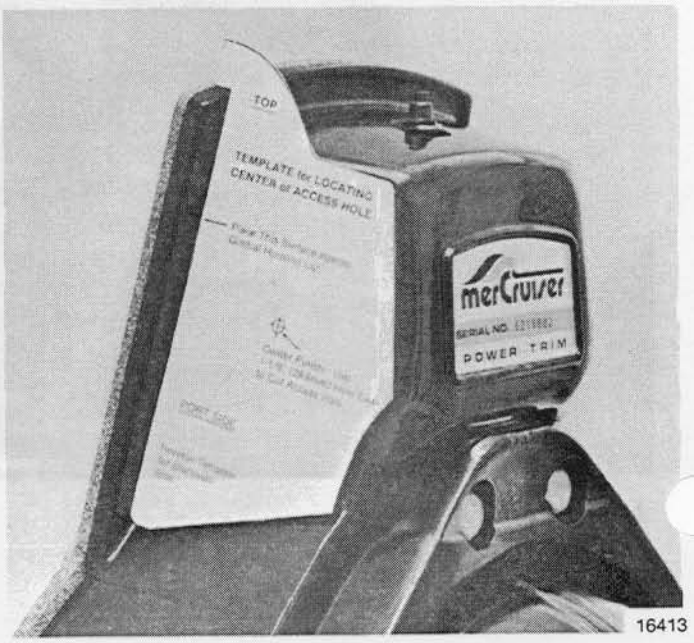
1. Lubricate upper swivel shaft with a liberal amount of 2-4-C Marine-Lube, to prevent metal chips from getting into bearings following.

a - Swivel Shaft Grease Fitting

⚠CAUTION

Be sure to position template accurately in the following steps. If holes are located improperly, it may not be possible to loosen steering lever screw and nut.

2. Cut out template (from kit) and position on gimbal housing. Mark gimbal housing with a center punch at location indicated.



3. Repeat same procedure on other side of gimbal housing, using opposite side of gimbal housing.

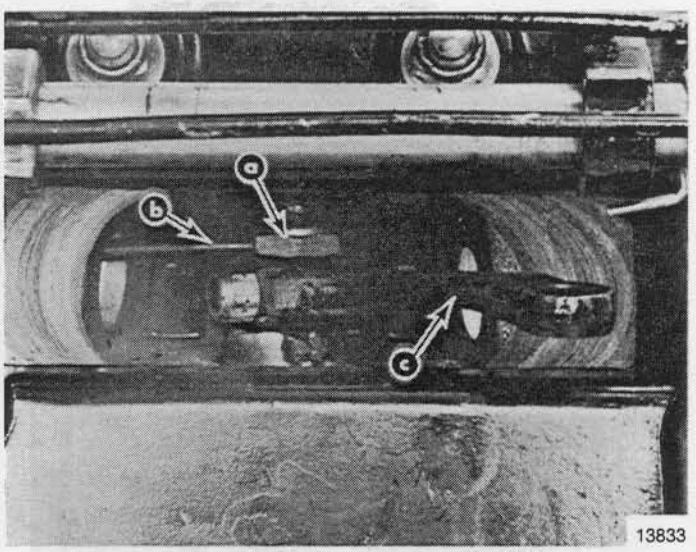
⚠CAUTION

Be sure to drill cut and thread holes perpendicular to gimbal housing surfaces in the following steps.

4. Drill same size hole as pilot rod (in hole saw being used) thru gimbal housing at marked locations. If using holes saw from 91-86191A1, drill 1/4" (6mm) holes.
5. Using 1-1/8 in. hole saw, cut holes thru gimbal housing at pilot hole locations. Remove metal chips with compressed air.
6. Position steering lever so that clamping screw and nut are accessible thru access holes. Using two 5/8 in. sockets, loosen screw and nut.

16407

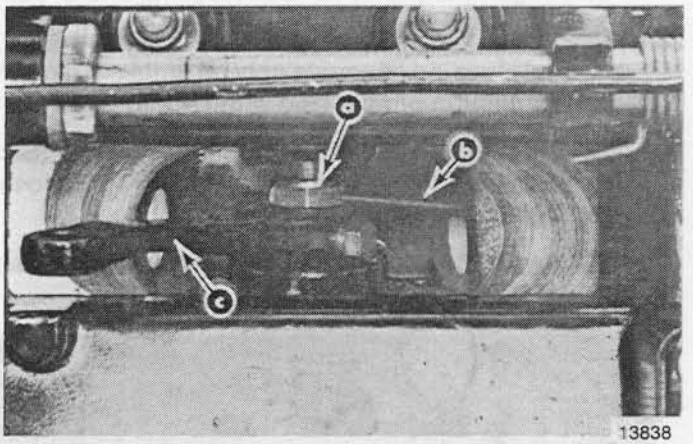
7. Unthread large elastic locknut from upper swivel shaft, using a pin punch.



13833

a - Locknut
b - Pin Punch
c - Steering Arm

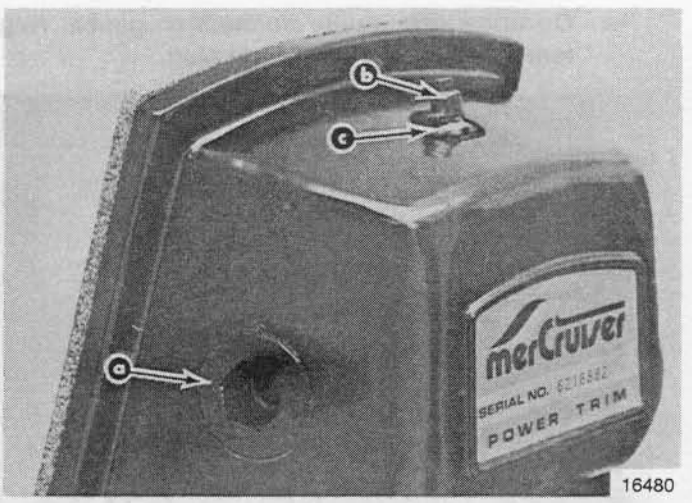
8. When reassembling, use special swivel shaft locknut from kit. This nut has grooves to allow easy tightening with a pin punch. Prior to installation, thread nut on and off swivel shaft once to cut threads into elastic (to ease installation).



13838

a - Groove Elastic Locknut
b - Pin Punch
c - Steering Arm

9. Upon reassembly, lubricate upper swivel shaft with 2-4-C Marine-Lube (to prevent metal chips from getting into bearings in next step).
10. Coat cutting portion of 1 in. NPT pipe tap with grease (to retain metal chips) and thread access holes in gimbal housing. Use only first 1/2" (13mm) of tap. Place a piece of tape on tap to indicate proper depth.
11. Remove metal chips with compressed air. Clean grease from threads with solvent.
12. Coat threads of plastic plugs (from kit) with Perfect Seal and thread into access holes until flush with housing. Use a 5/8 in. allen wrench or a 5/8" hex head bolt.



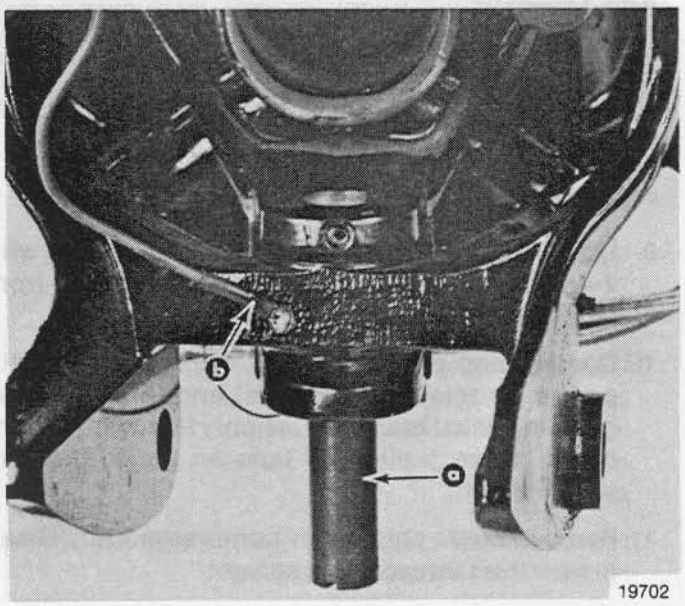
16480

a - Plastic Plug (Typical Both Sides)

13. Touch up any bare metal spots with Primer and Phantom Black Spray Paint.

Removal

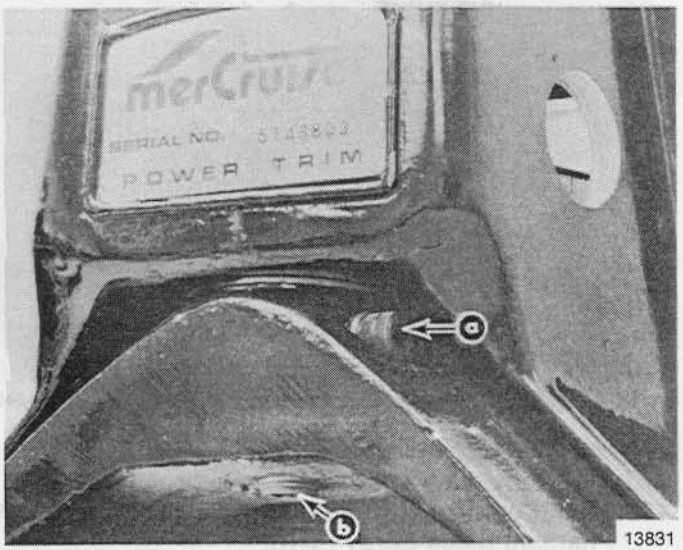
1. Remove the following:
   a. Stern Drive Unit (Sec. 2)
   b. Hinge Pins (Refer to "Bell Housing and U-Joint Bellows Servicing")
   c. Bell Housing (Remove only on units with square connection gimbal ring with U-bolt)
2. Disconnect trim cylinders from gimbal ring. (Sec. 5) Suspend cylinders to prevent hydraulic hoses from being damaged.
3. Remove cotter pin and lower swivel pin. Disconnect ground wire, if so equipped.



19702

a - Lower Swivel Pin
b - Ground Wire

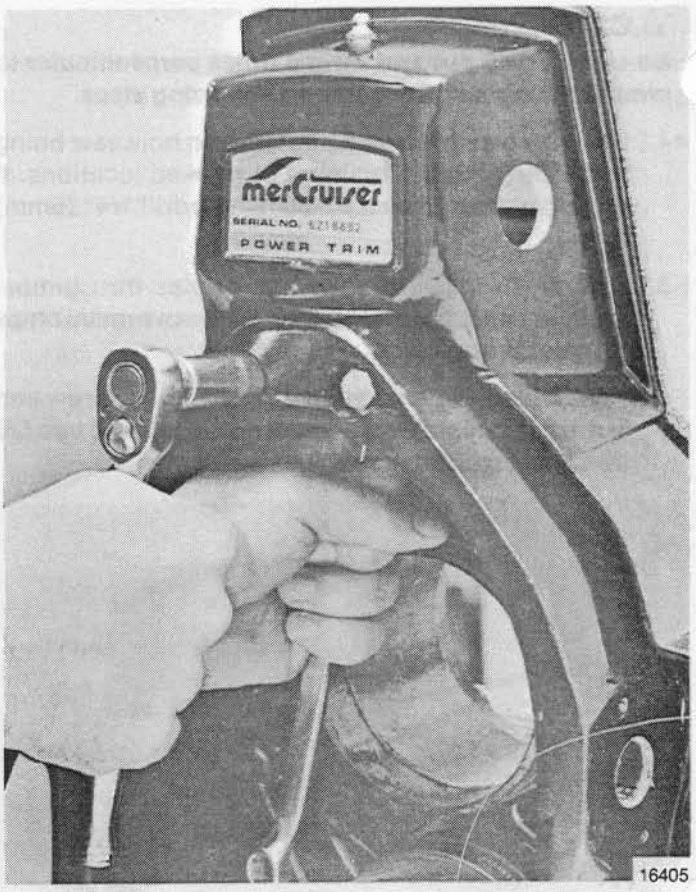
4. Loosen or remove fasteners as shown.
   a. On units with spline connection gimbal ring, remove retaining screw and plug.



13831

a - Retaining Screw
b - Plug

   b. On units with square connection gimbal ring with thru bolts, loosen bolts and nuts.

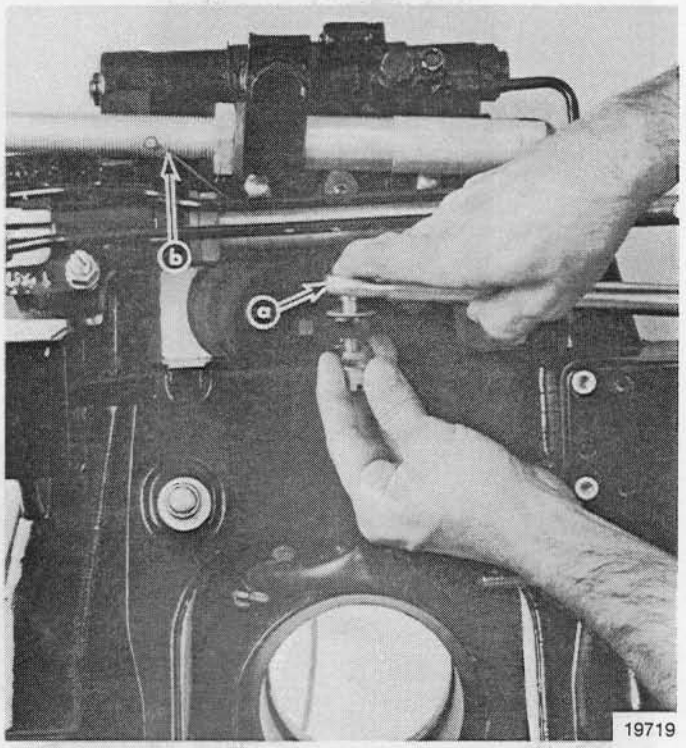


16405

   c. On units with square connection gimbal ring with U-bolt, loosen U-bolt nuts.

19712

5. Disconnect steering link rod from lever. Disconnect ground wire, if so equipped.

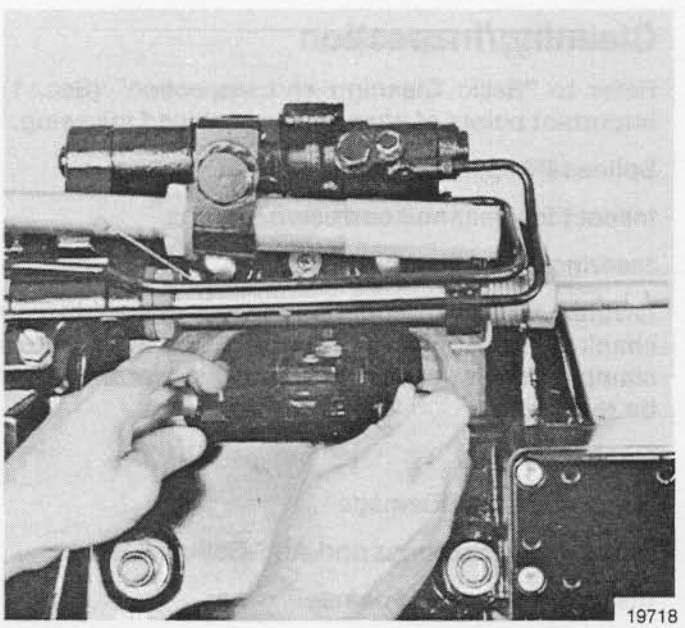


19719

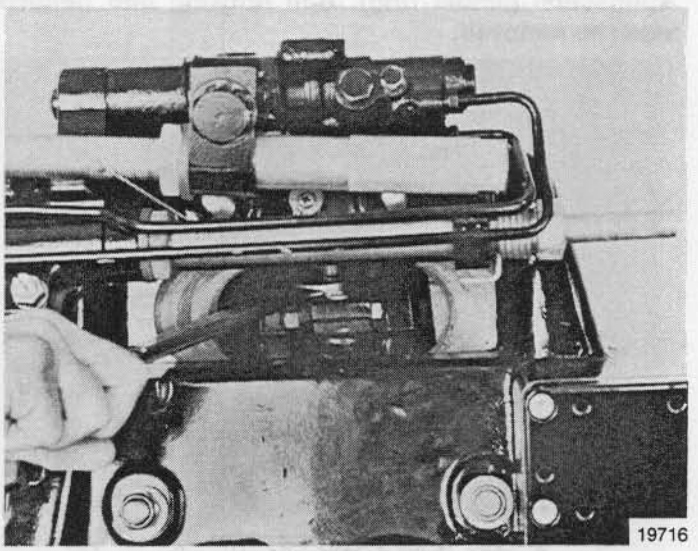
a - Steering Link Rod
b - Ground Wire

IMPORTANT: If steering arm attaching hardware is not accessable using wrenches, the access plug kit previously described and that method of removal must be used.

6. Loosen steering lever clamping screw and nut.


19718

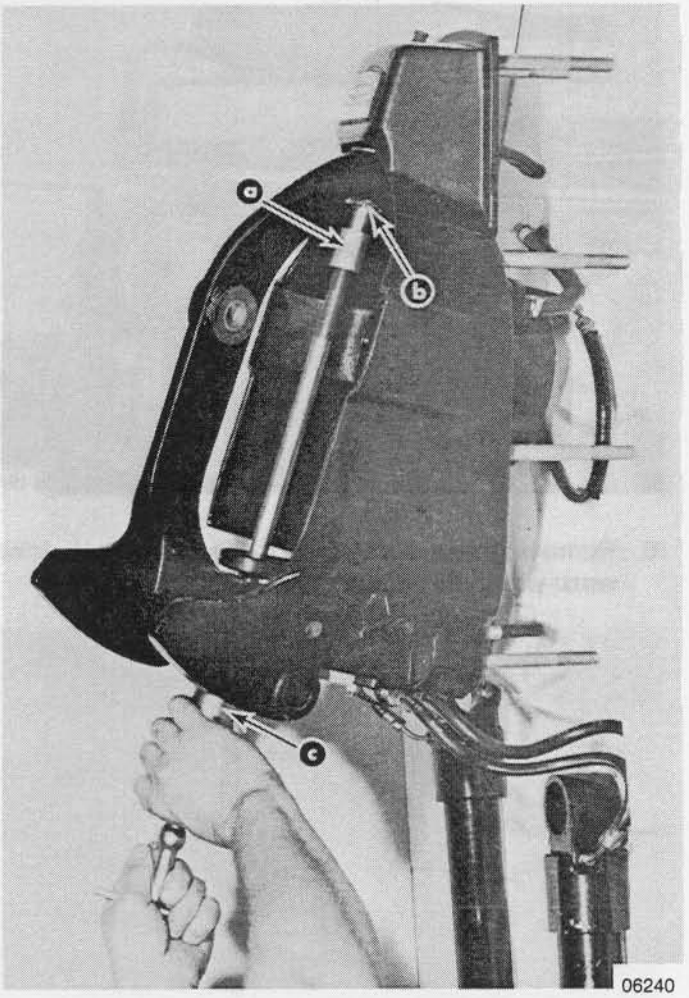
7. Unthread elastic locknut from swivel shaft, using a 1-1/16 in. open end wrench. It may be necessary to drive swivel shaft downward (as outlined in next step) to completely unthread nut.


19716

8. Remove grease fitting and drive swivel shaft downward with a pin punch.

19714

IMPORTANT: If swivel shaft is seized, remove shaft using Slide Hammer Puller, 91-34569A1 and Puller Head, 91-38919 (on units with spline connection gimbal ring) or Puller Head, 91-63616 (on units with square connection gimbal ring). Bell housing and bellows must be removed.



06240

a - Puller Head
b - Swivel Shaft
c - Slide Hammer

9. Remove washer and swivel shaft.

19713

a - Washer
b - Swivel Shaft

Cleaning/Inspection

Refer to "Basic Cleaning and Inspection" (Sec. 1). Important points of attention are outlined following.

Splines (If Applicable).

Inspect for wear and corrosion damage.

Steering Lever Clamping Screw.

On units with spline connection steering lever, inspect shank on steering lever clamping screw. If worn, clamping screw, steering lever and swivel shaft must be replaced.

Gimbal Ring.

Refer to "Impact Damage".

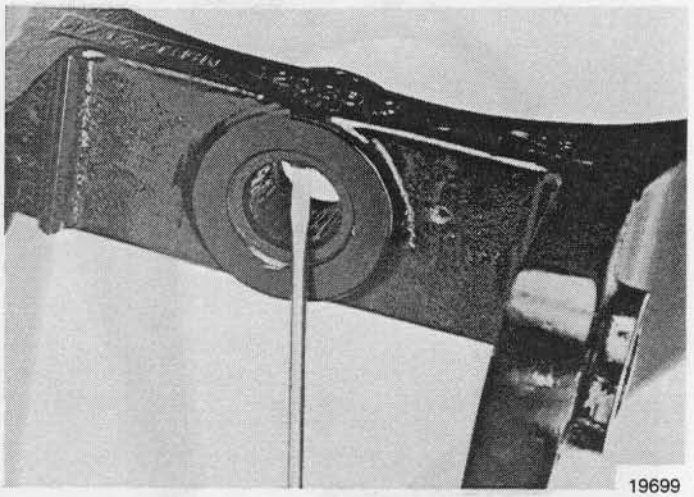
Gimbal Ring Bushings and Anti-Galling Washers.

Inspect for wear and damage.

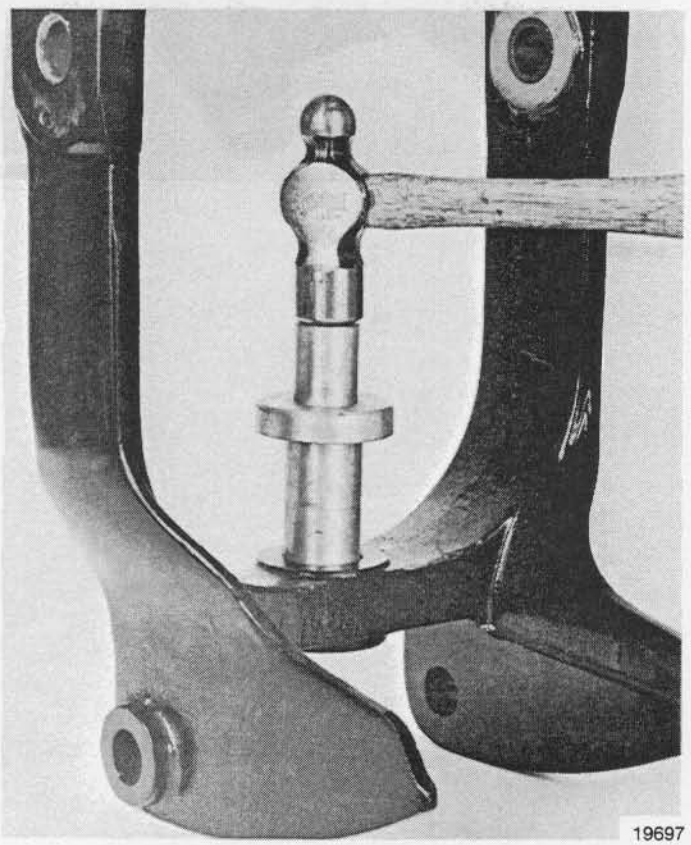
Component Replacement

Swivel Pin Needle Bearing and Seals

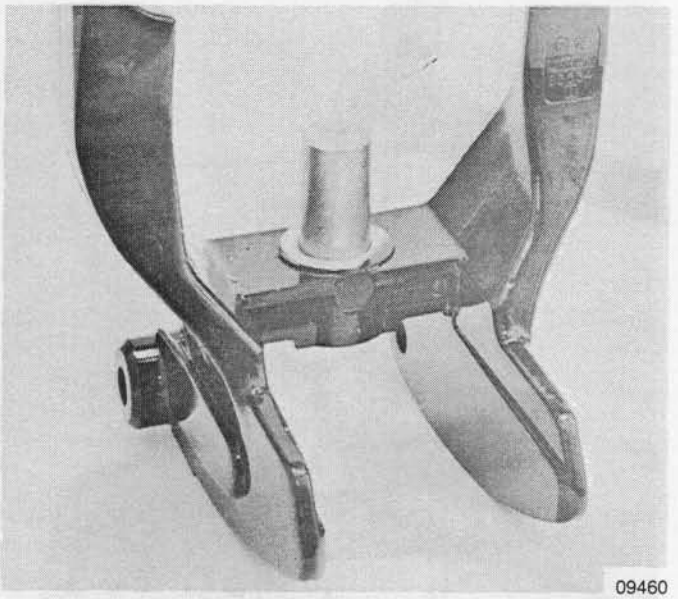
1. If seals only require replacement, remove them with a screwdriver.


19699

2. If seals and bearing require replacement, remove them using a suitable mandrel.

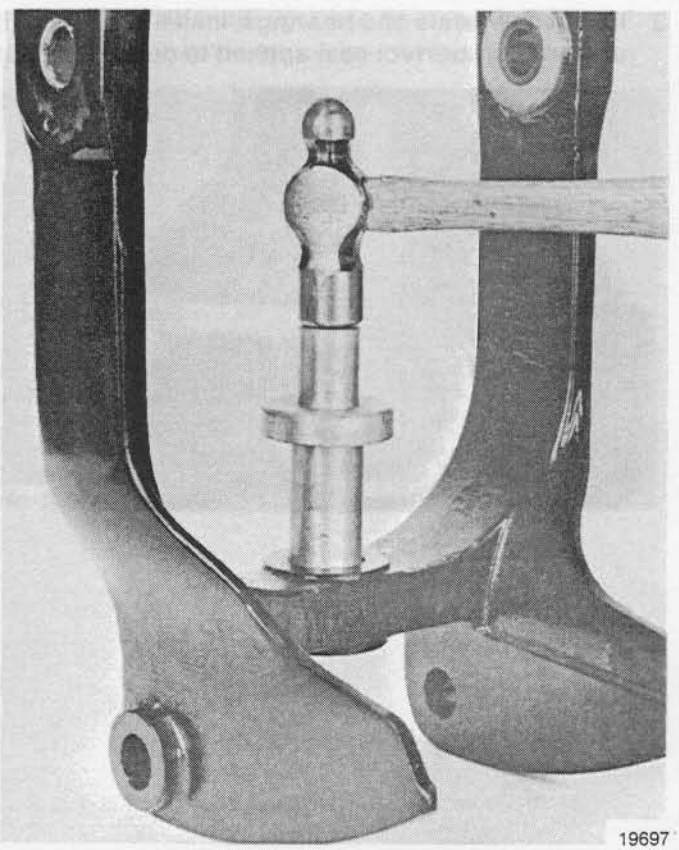

19697

3. Install new seals and bearing, install seals with lip toward top of gimbal ring and perfect seal applied to outer diameter.

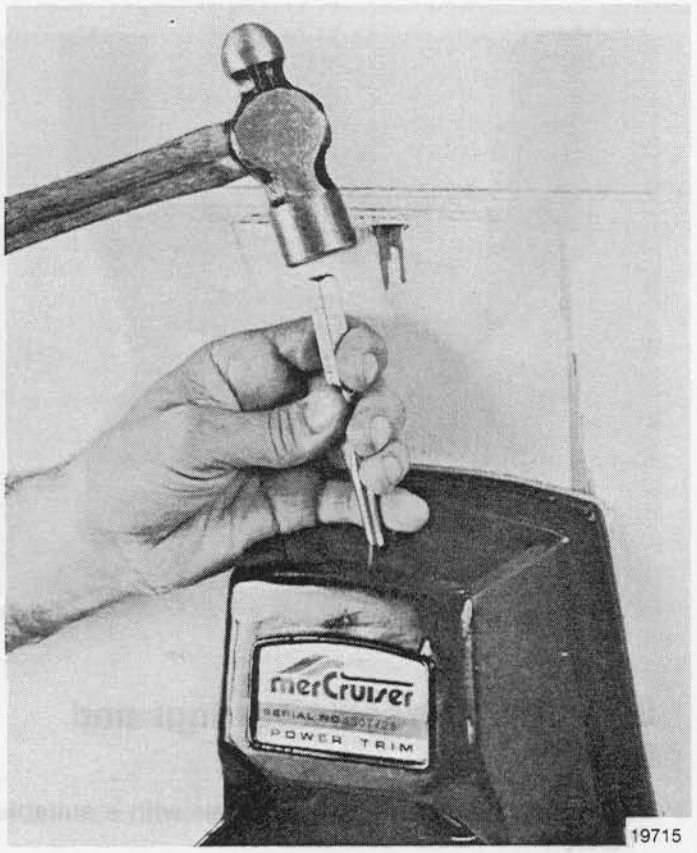

09460

Swivel Shaft Needle Bearings and Seals

1. Drive out lower bearing and seals with a suitable driver.

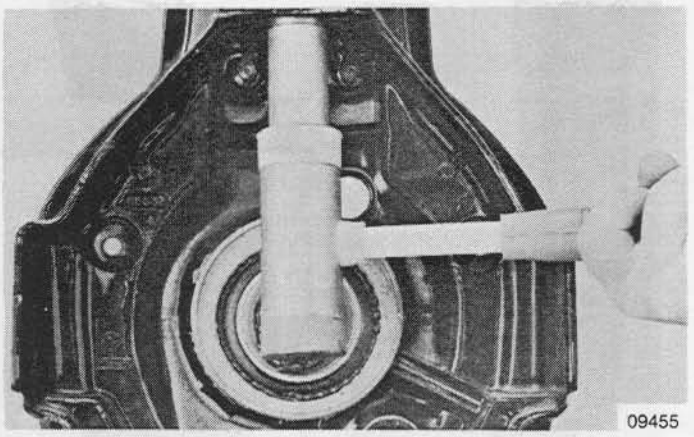

19697

2. Remove upper bearing and seal, using a punch. Parts must be replaced if removed.



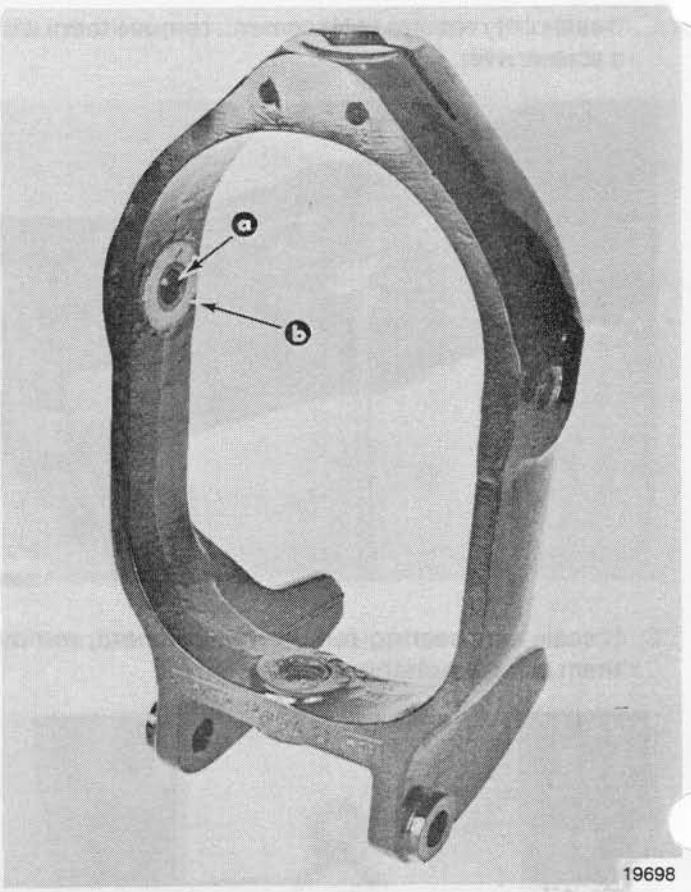
19715

3. Install new seals and bearings, install seals with lip upward and perfect seal applied to outer diameter.


09455

GIMBAL RING BUSHINGS and ANTI-GALLING WASHER

If replacement is required, install new bushings and washers with epoxy glue.



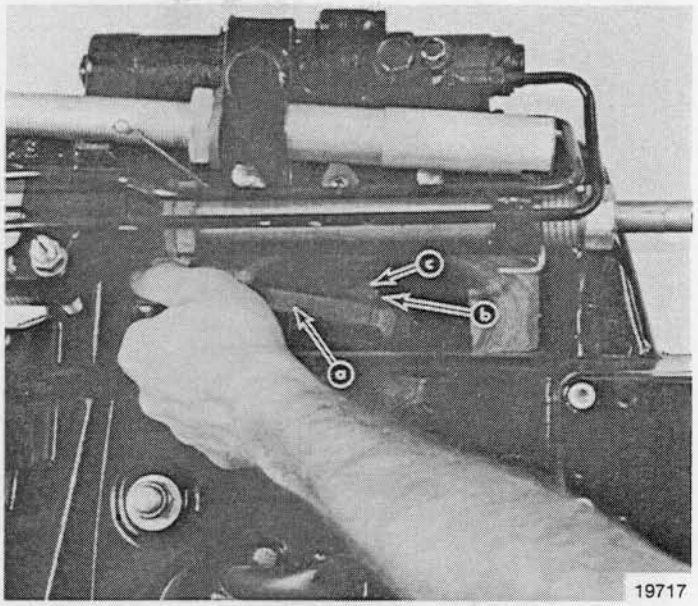
19698

a - Bushings
b - Washer

Installation

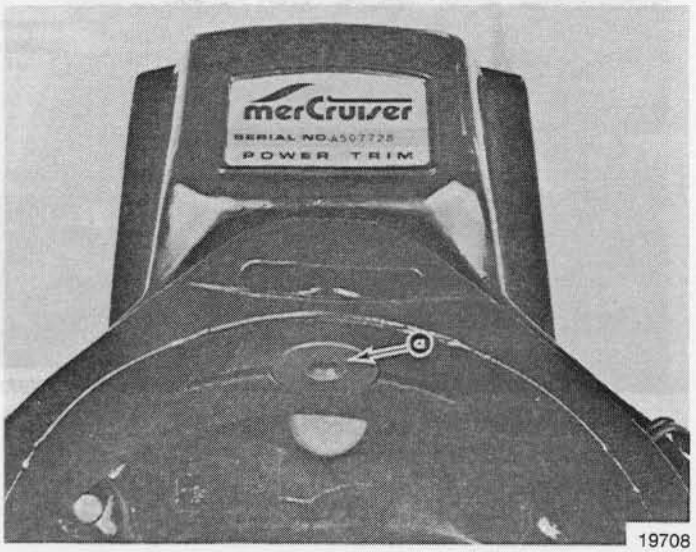
IMPORTANT: If upper swivel shaft bearings require replacement, refer to "Gimbal Housing Servicing".

1. Install clamping screw and nut in steering lever.
2. Install steering lever, washer and elastic locknut. Align components by inserting finger up thru swivel shaft bore in gimbal housing and retain with a screwdriver.



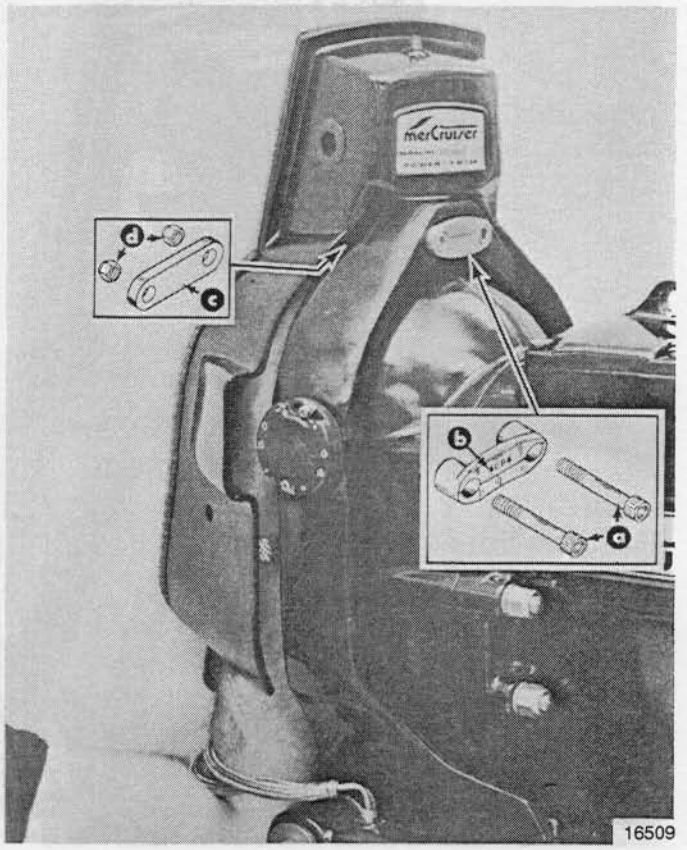
a - Steering Lever
b - Washer
c - Elastic Locknut

3. Coat swivel shaft and gimbal ring mating surfaces with Special Lubricant 101.
4. If installing new components, ensure that upper swivel shaft fits all the way into gimbal ring. Shoulder on shaft must bottom out against ring. If necessary, clean up mating surfaces with a file.



a - Upper Swivel Shaft

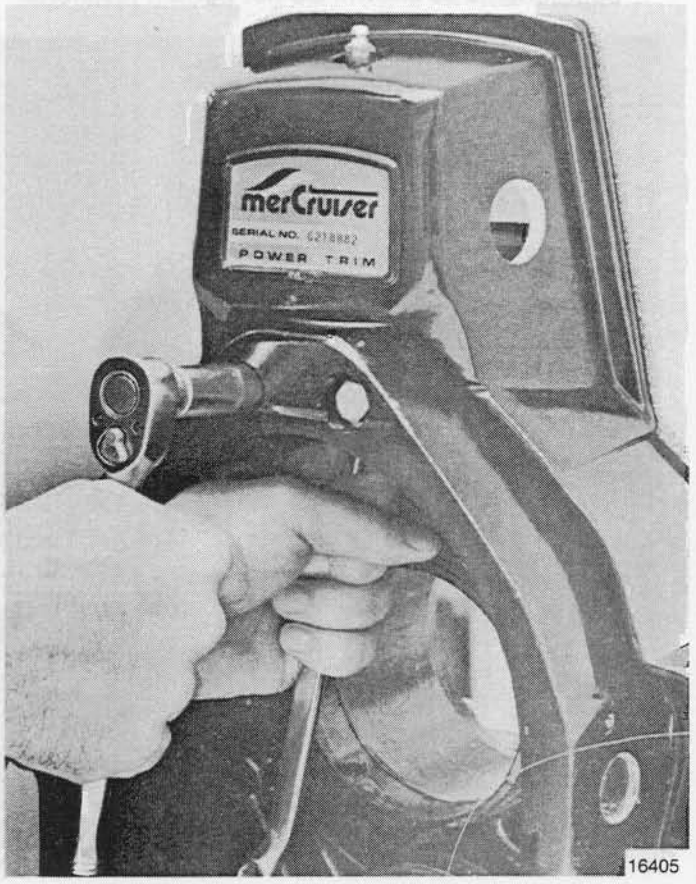
5. On units with square connection gimbal ring, install components as shown. Do not tighten fasteners.



a - Bolts (Coat Shank and Threads with Special Lubricant 101)
b - Clamp Bracket (Install with Arrow Upward)
c - Backing Plate
d - Elastic Stop Nuts

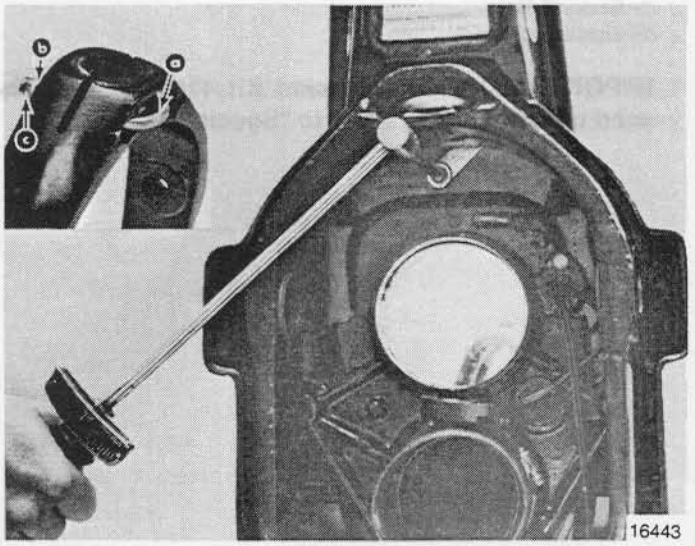
IMPORTANT: Clamp Bracket Kit 41456A1 must be used on these units. Refer to "Special Information".

Gimbal Ring With Thru Bolts



16405

Gimbal Ring With U-Bolt



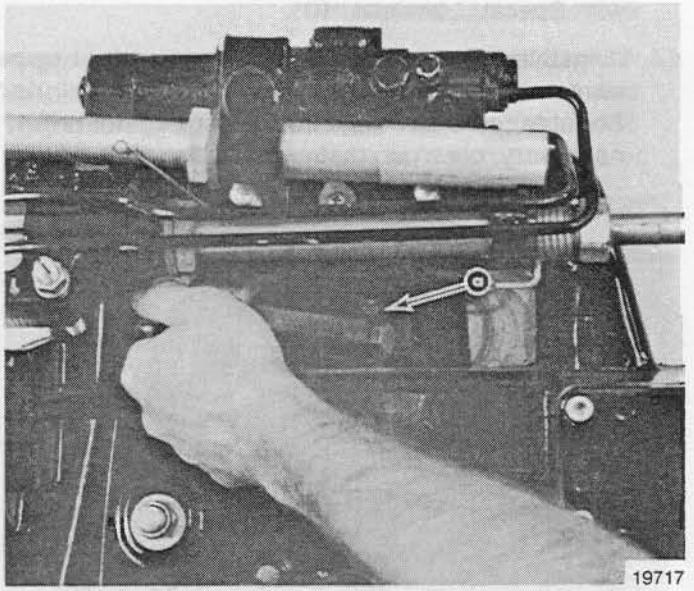
16443

a - U-Bolt (Coat Shanks and Threads with Special Lubricant 101)
b - Backing Plate
c - Elastic Stop Nuts

6. Install gimbal ring, washer and swivel shafts and thread on elastic locknut, being sure to align components as shown. If bell houisng is installed, it will be necessary to pull out and downward on gimbal ring and bell housing, (as shown) to install swivel shaft.

13835

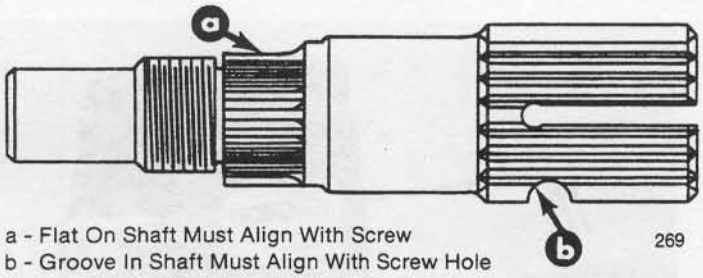
a - Washer



19717

a - Elastic Locknut

UNITS WITH SPLINE-SPLINE SWIVEL SHAFT

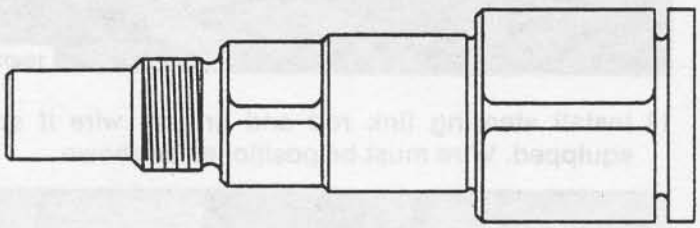


a - Flat On Shaft Must Align With Screw
b - Groove In Shaft Must Align With Screw Hole

269

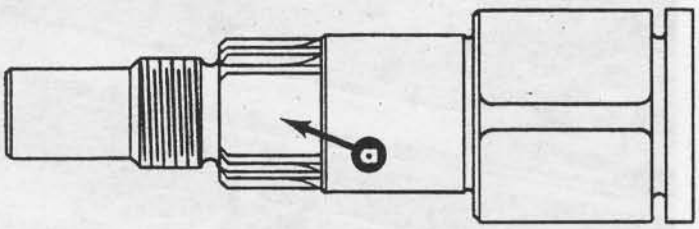
UNITS WITH SQUARE-SQUARE SWIVEL SHAFT

Shaft Can Be Installed In Any One of Four Positions



859

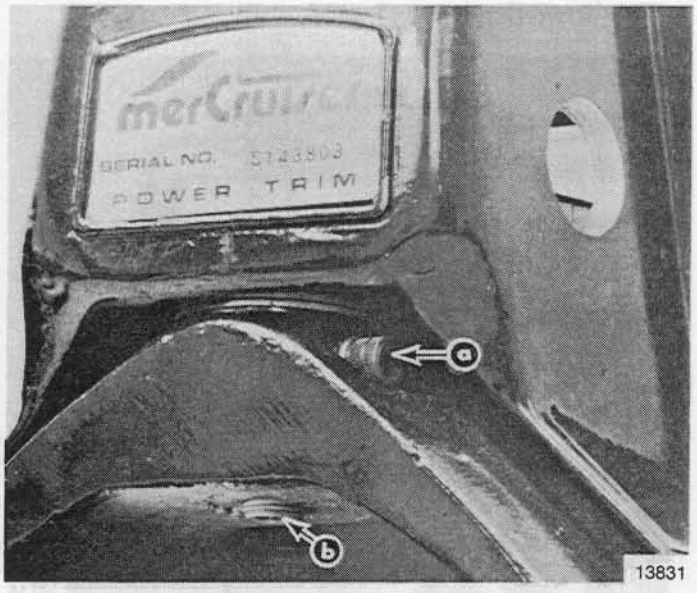
UNITS WITH SQUARE-SPLINE SWIVEL SHAFT



a - Flat On Shaft Must Align With Screw

383

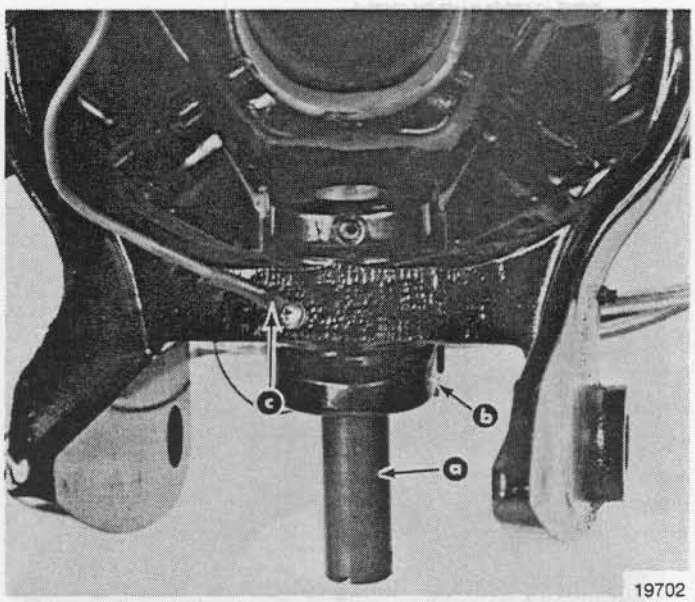
7. On units with spline connection gimbal ring, apply Special Lubricant 101 to retaining screw and plug and install.



13831

a - Retaining Screw (Tighten Securely)
b - Plug [Torque to 40-45 Lbs. Ft. (54 - 61 N.m)]

8. Install lower swivel pin with new cotter pin. Reconnect ground wire, if so equipped.

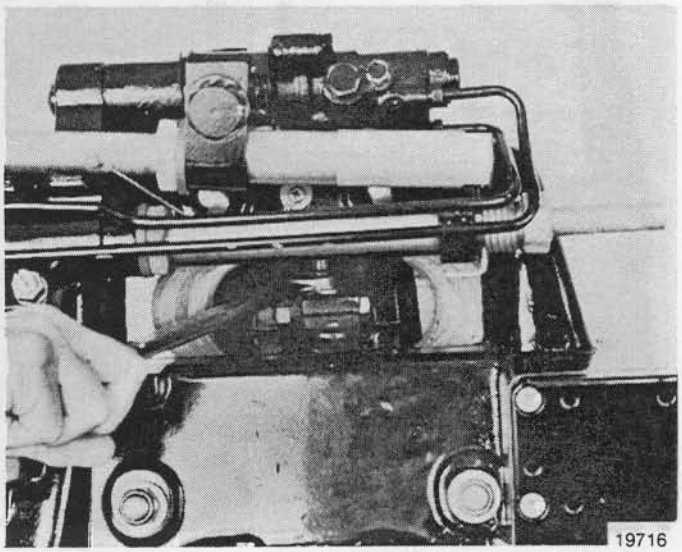


19702

a - Lower Swivel Pin
b - Cotter Pin
c - Ground Wire

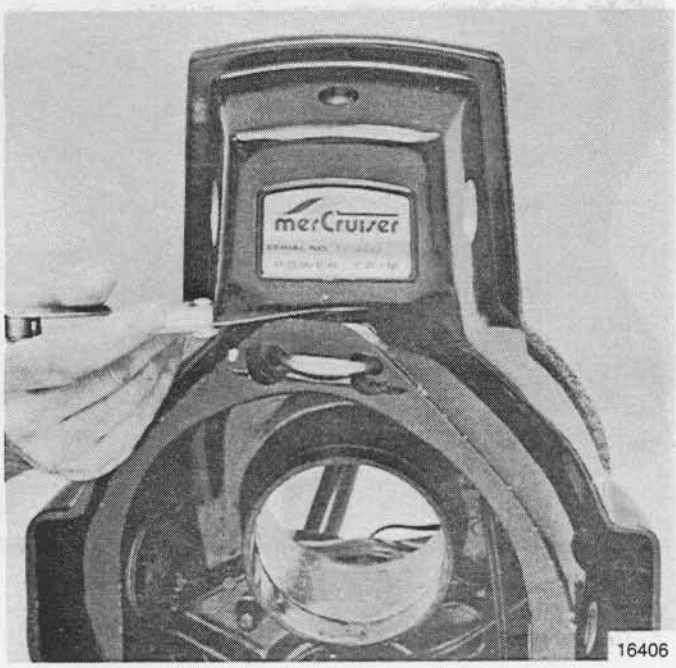
9. Tighten swivel shaft locknut as follows:

   A. Tighten swivel shaft locknut with a 1-1/16 in. open end wrench until all gimbal ring up and down play is eliminated.


19716

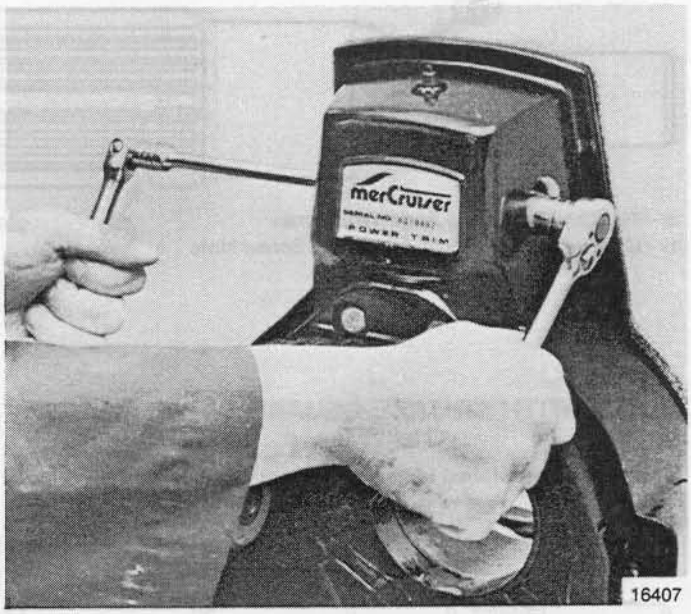
   B. Using a rawhide hammer, hit downward on gimbal ring support flanges.

   C. Loosen or tighten locknut to obtain a clearance of .005 - .007 in. (.13 - .18mm) between washer and gimbal housing.



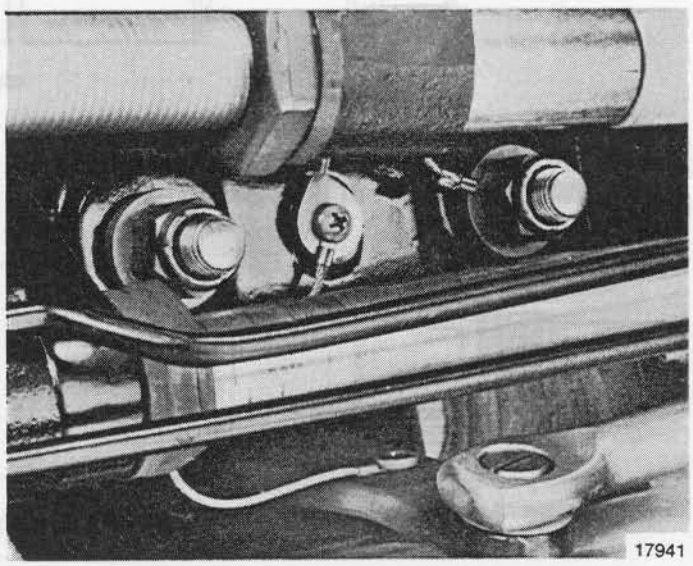
16406

10. Tighten steering lever clamping screw and nut securely [55 - 60 Lbs. Ft. (75 - 81 N.m)].



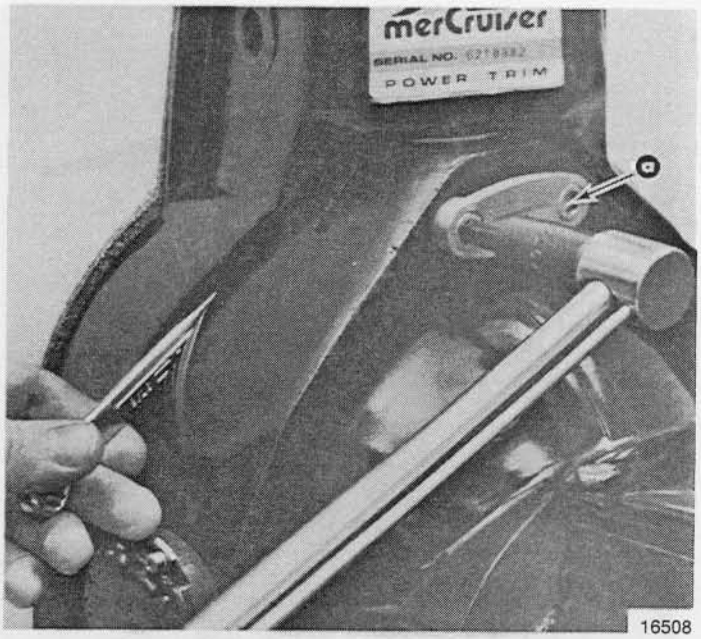
16407

11. Install steering link rod and ground wire if so equipped. Wire must be positioned as shown.


17941

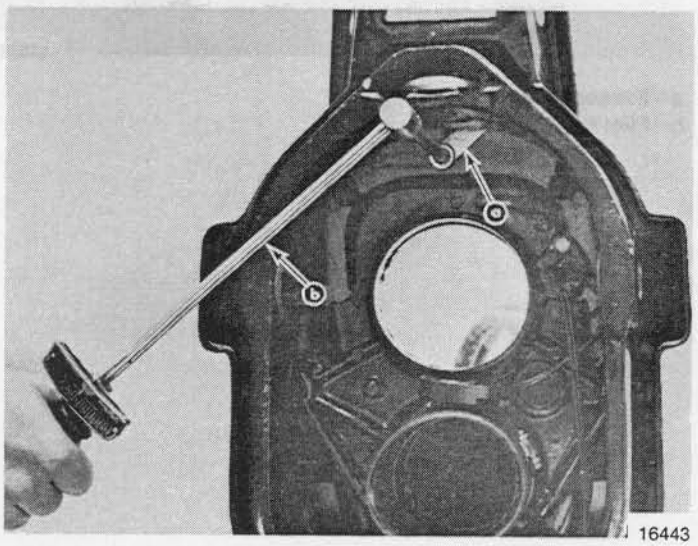
12. On units with square connection gimbal ring, torque fasteners as shown.

GIMBAL RING WITH THRU BOLTS



a - Torque to 25 Lbs. Ft. (34 N.m) In 3 Progressive Steps (10, 20 and 25)

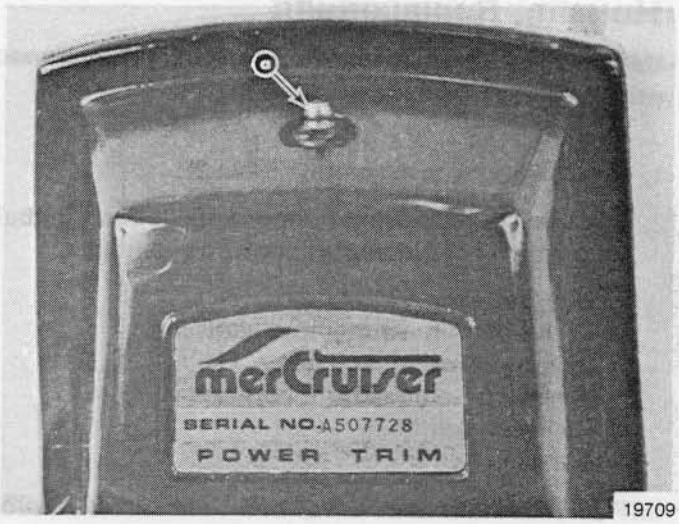
GIMBAL RING WITH U-BOLT



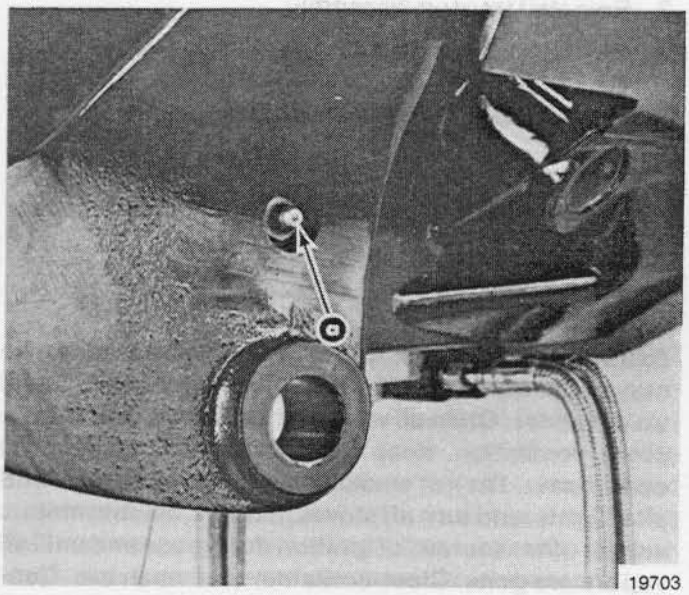
a - Torque Adaptor
b - Torque Wrench

Torque to 40 lbs. ft. (54 N.m) in 4 progressive steps (snug, 10, 20, 40).

13. Install grease fitting and lubricate upper swivel shaft and lower swivel pin with 2-4-C Marine-Lube. Reinstall protective caps.



a - Grease Fitting



a - Grease Fitting

14. Install the following:

    Bell housing and/or hinge pins (outlined preceding
    Stern drive unit (Sec. 2)
    Trim Cylinders (Sec. 5)

15. Touch up any bare metal spots with primer, and Phantom Black Spray Paint.

Gimbal Housing Servicing

Housing Replacement

IMPORTANT: To ease removal, break hinge pins loose prior to removing transom assembly.

1. Remove transom assembly. (Sec. 2)
2. Transfer the following components to new gimbal housing, using procedure previously outlined.

   Bell housing
   Trim position sender and leads and trim limit switch and leads
   Hydraulic connector and hoses
   Oil reservoir hose
   Gimbal ring

IMPORTANT: All other components are included with new gimbal housing.

3. Reinstall transom assembly.

Component Replacement

STUDS

Install new studs with Loctite "A" applied to threads.

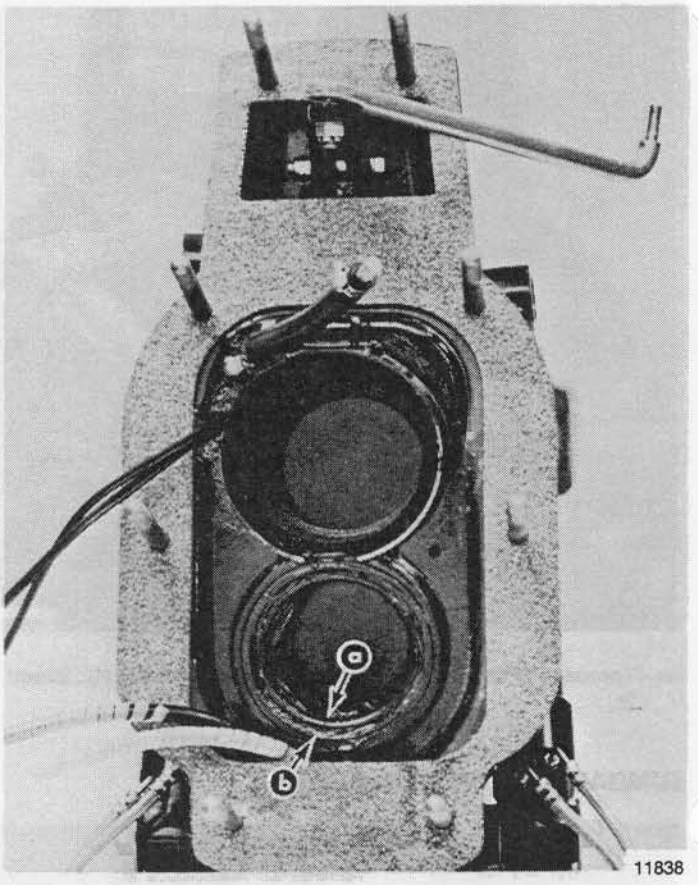
EXHAUST PASSAGE SEAL

⚠WARNING

Extremely flammable! Vapors from Bellows Adhesive may cause flash fire or ignite explosively. Prevent build up of vapors. Open all windows and doors. Use only in cross ventilation. Keep away from heat, sparks and open flame. Do not smoke. Extinguish all flames and pilot lights, and turn off stoves, heaters, electric motors and all other sources of ignition during use and until all vapors are gone. Close container after each use. Contains Toluol and petroleum distillates. Harmful or fatal if swallowed. Avoid prolonged contact with skin or breathing of vapors. If swallowed, do not induce vomiting. Call physician immediately. Keep out-of-reach of children.

Install new "O" ring, using Bellows Adhesive to retain. Lubricate "O" ring with 2-4-C Marine-Lube.

If pilot ring is damaged, install new ring with Loctite Primer "T" and Loctite No. 35 applied to outer diameter.



11838

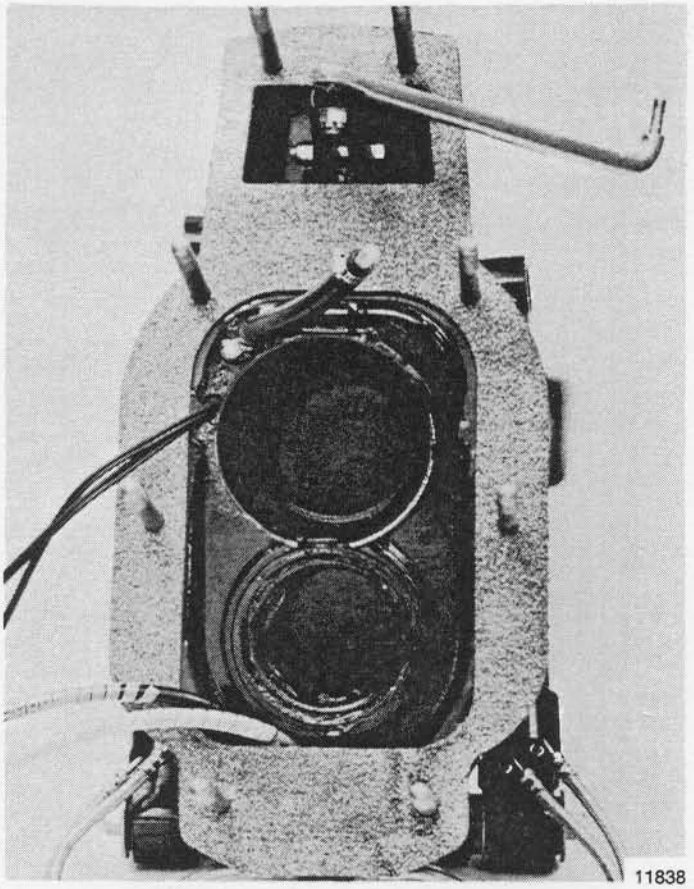
a - Exhaust Passage "O" Ring
b - Pilot Ring

TRANSOM GASKET

⚠WARNING

Refer to Warning under "Exhaust Passage Seal," preceding.

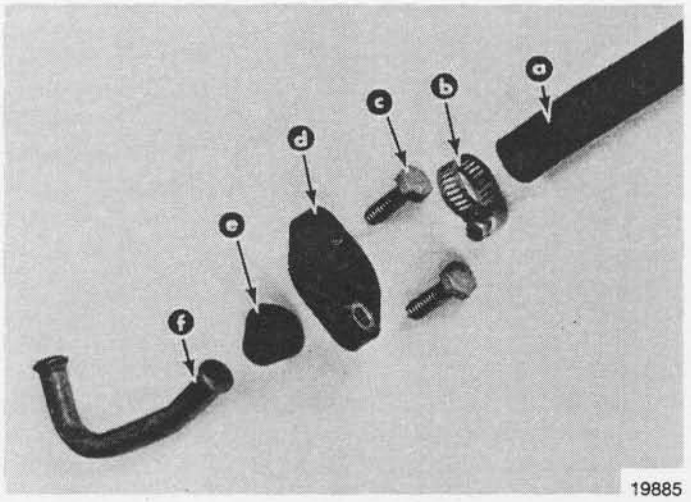
Install new gasket, using Bellows Adhesive to retain. Do not use other than this product.



11838

Oil Tube

Remove and install as shown.



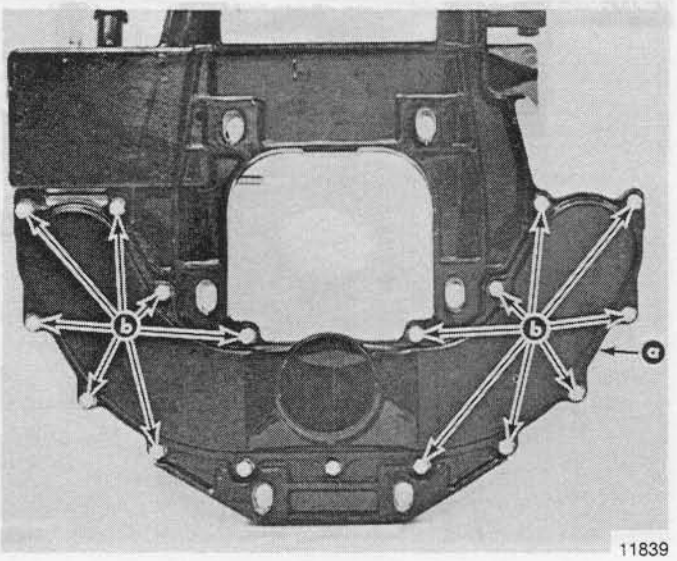
19885

a - Hose
b - Clamp
c - Screws (Coat Threads With Perfect Seal)
d - Retainer
e - Bushing (Coat With Perfect Seal)
f - Tube

Inner Transom Plate Servicing

Exhaust Cover

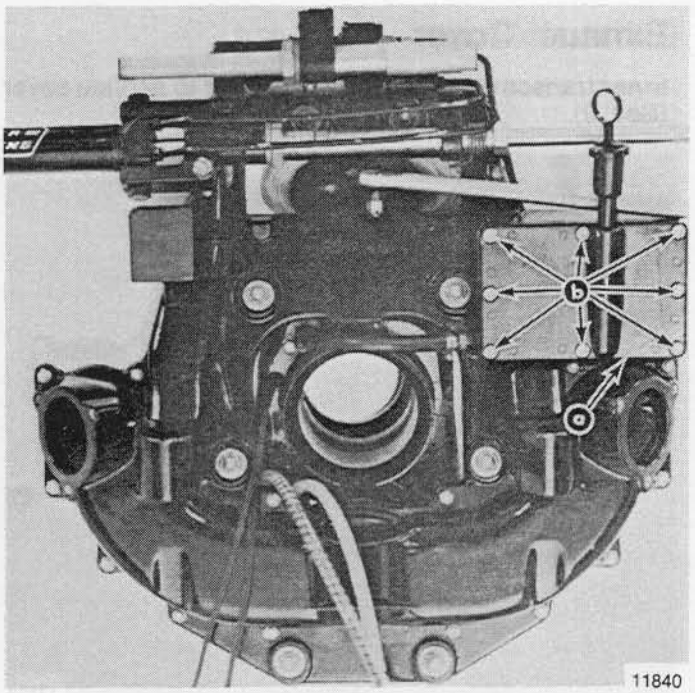
Inner transom plate must be removed to service cover (Sec. 2).



11839

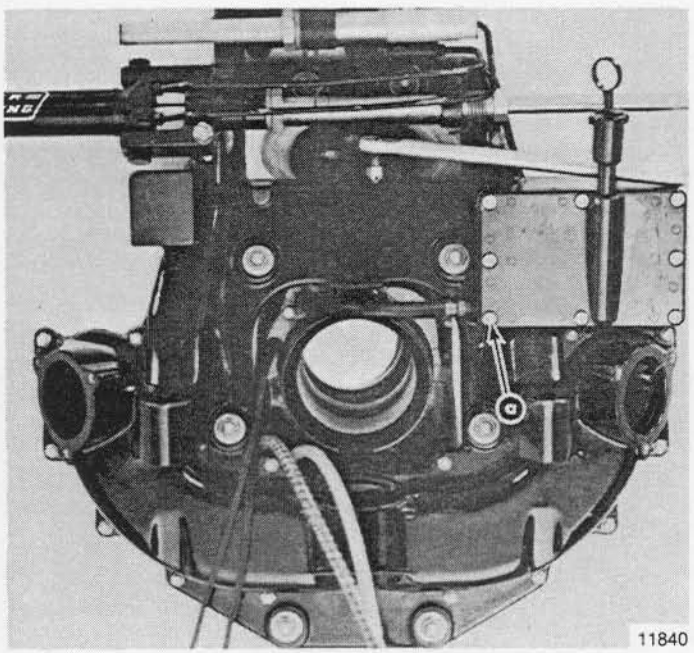
a - "O" Ring (Coat With Perfect Seal) (Not Shown)
b - Screws and Nuts (Tighten Securely)

Oil Reservoir



a - Gasket (Coat With Perfect Seal) (Not Shown)
b - Screws (Tighten Securely)

Coat threads on this screw with perfect seal.

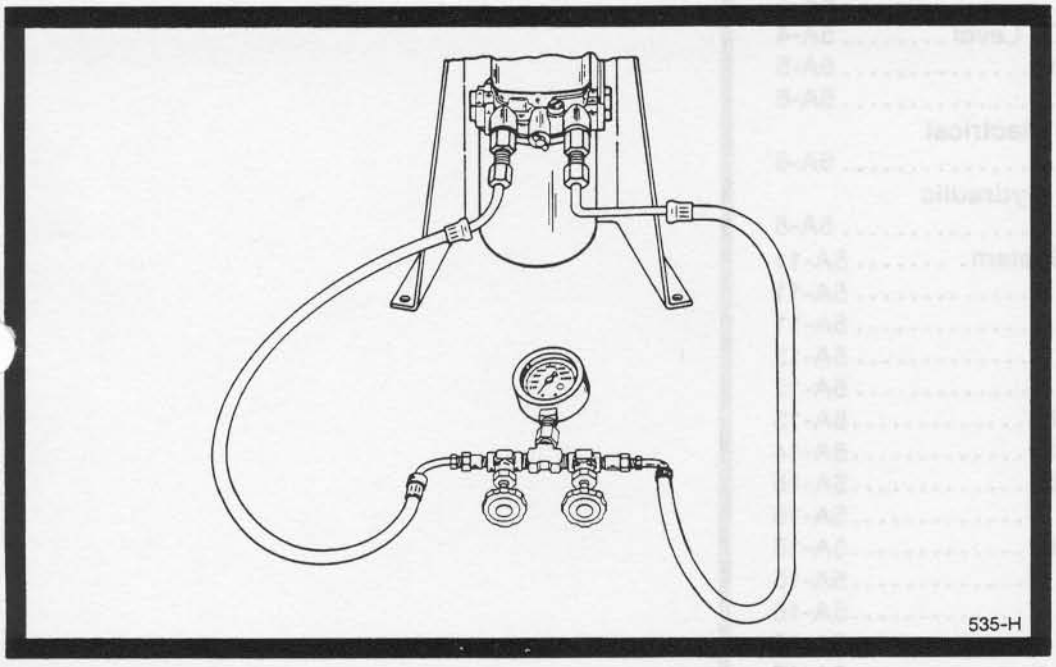


a - Screw

Power Steering Unit

Refer to Section 6-A

POWER TRIM



OILDYNE POWER TRIM PUMP

5A

mercruiser
STERN DRIVES & INBOARDS

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IDENTIFICATION

All MerCruiser TR and TRS Stern Drives are equipped with either the Oildyne or Prestolite Power Trim pump. The Oildyne Power Trim pump is covered in this section. Refer to "Part B" or "Part C" for Prestolite pump information. (See "Index")

The Oildyne Power Trim pump may be visually identified by the Power Trim pump's "round" reservoir. (Figure 1)

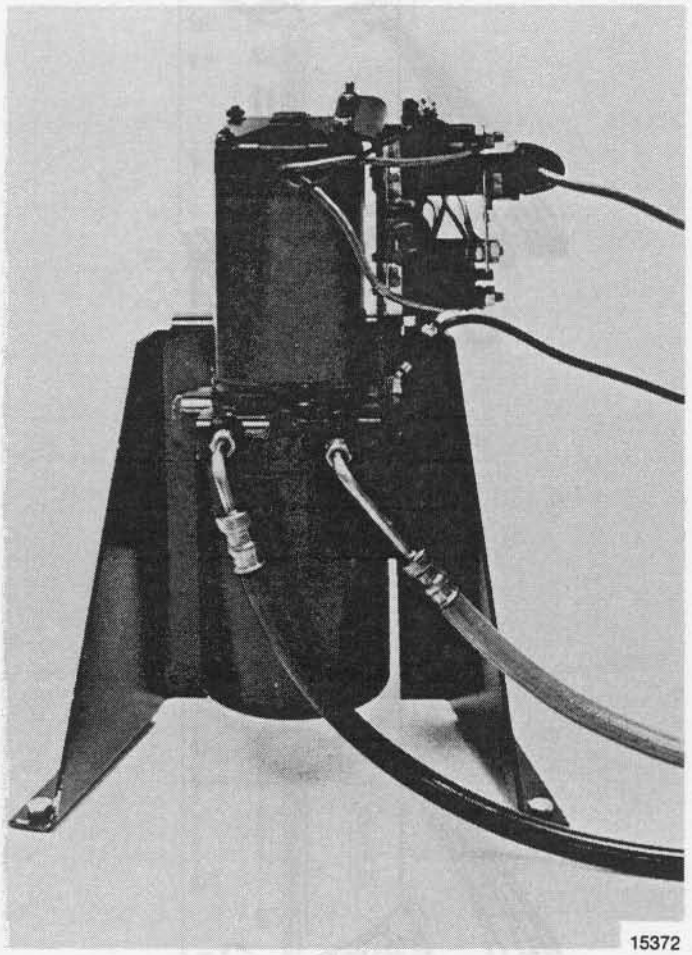


Figure 1. Oildyne Power Trim Pump

SPECIFICATIONS

VALVE PRESSURE SPECIFICATIONS

Valve	Pressure
Up Circuit	2200-2600 P.S.I. (15173-17932 kPa)
Down Circuit	400-600 P.S.I. (2759-4138 kPa)

TORQUE SPECIFICATION

Pump to Adaptor Screws	75 lbs. in. (8 N.m)

SPECIAL TOOLS

Test Gauge Kit	91-52915A3
Multi-Meter (Ohmmeter)	91-99750
Torx Socket	Obtain Locally

QUICKSILVER LUBRICANTS, ADHESIVES, and SEALERS

2-4-C Multi-Lube	92-90018A12
Liquid Neoprene	92-25711-1
Needle Bearing Assembly Lubricant	92-42649A1

ELECTRICAL SPECIFICATION

Pump Amperage Draw	115 Amps at 2200-2600 P.S.I. (15173-17932 kPa)

DESCRIPTION

The Oildyne Power Trim Pump has internal valving that eliminates the need for an external reverse lock, as was required in the past. The pump generates a higher volume of fluid, but at lower pressure than previous pumps. This, in conjunction with larger I.D. hydraulic hoses (gimbal housing to pump) and larger I.D. trim cylinders, should allow the drive unit to "kick-up" easier if an underwater object is struck.

⚠CAUTION

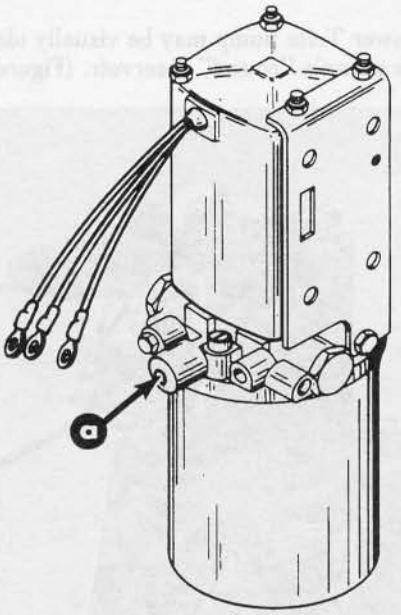
Due to differences in internal valving, the Oildyne trim pump cannot be used to replace an earlier high pressure Prestolite pump, or vice-versa. Use of incorrect pump will affect trim operation and may cause damage to trim system.

The pump motor is protected from overheating by an internal circuit breaker (in the field), which interrupts the ground circuit to the solenoids if an overheating condition is sensed. Electrical current overload protection is afforded to the pump by a 110-amp fuse. Pump also is equipped with a 20-amp circuit breaker (on older pumps) or a 20-amp fuse (on new pumps), which serves to protect the trim control and harness from an overload.

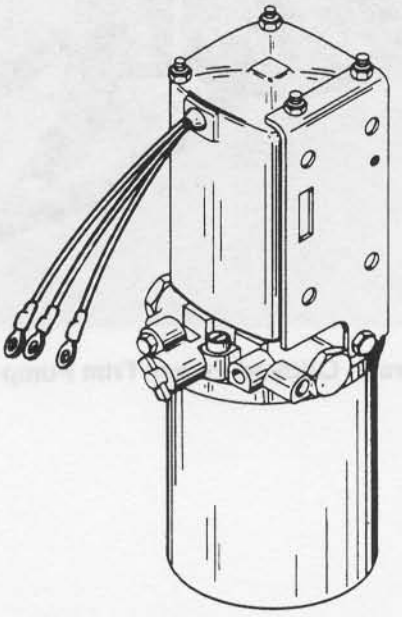
SPECIAL INFORMATION

MANUAL RELEASE VALVE REMOVAL

Later production "Oildyne" Power Trim pumps will no longer have a "Manual Release Valve".



Later Production Pump

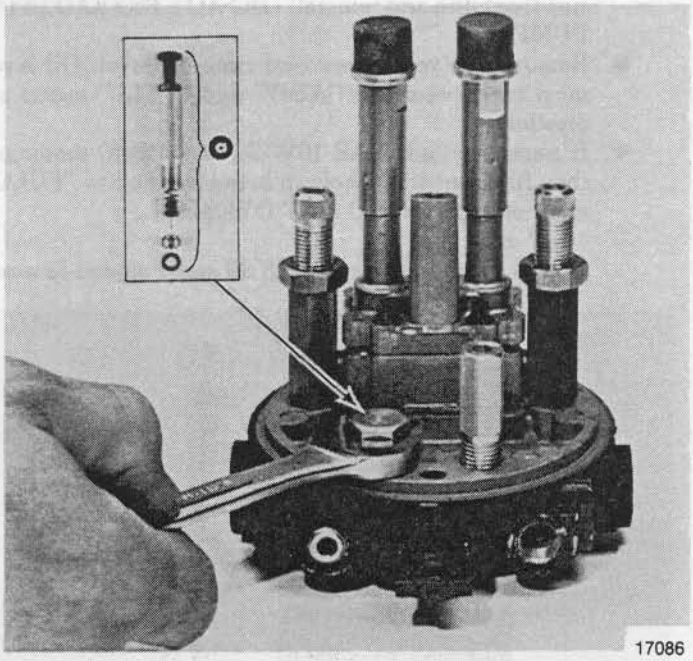


Older Production Pump

a - Manual Release Valve Has Been Removed From This Location

TRAIL-OUT VALVE REMOVAL

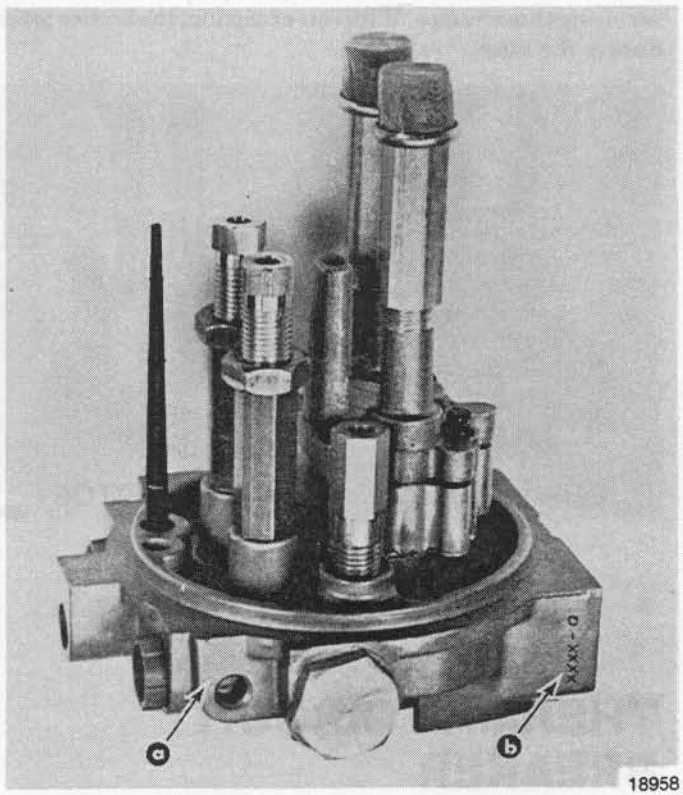
Early production Oildyne pumps were equipped with a trail-out valve. This valve was eliminated on later pumps. If this valve should fail on one of the early production pumps, the valve can be removed and replaced with plug 19-11005.



a - Trail-Out Valve - Replaced with Plug 19-11005

NEW ADAPTOR and RESEVOIR

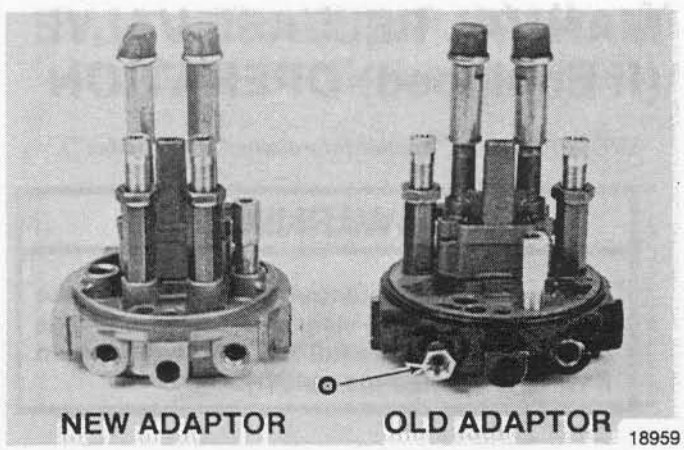
Later production Oildyne pumps are equipped with a new adaptor. Accompanying this change, an aluminum (instead of stamped steel) oil reservoir was utilized.



a - Adaptor
b - Date Code Letter (Follows Number)
New Casting - "Q"
Old Casting - "P"

New Adaptor Identification

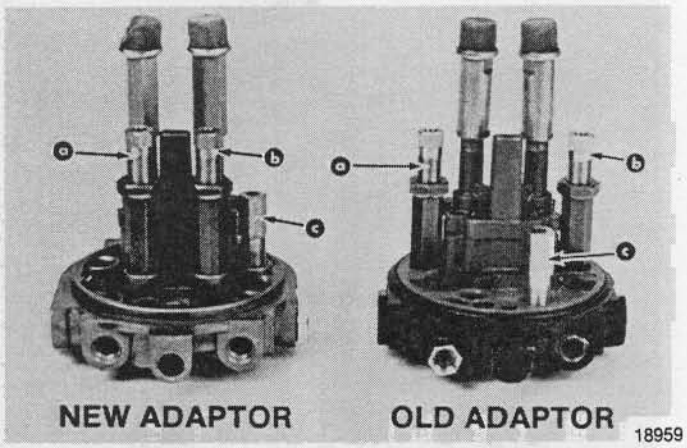
Adaptor fitting is no longer required on pumps with new adaptor. The gray hydraulic ("Down") hose now attaches directly to adaptor, the same as the black hydraulic hose.



a - Adaptor Fitting - Used with Old Adaptor

With the exception of the aforementioned items, all other components are the same as those used on the older production pumps.

The locations of the pressure relief valves has been changed. Be sure to install the valves in the proper location when servicing these pumps. With this exception, the service procedure is the same.



a - Down Pressure Relief Valve
b - Up Pressure Relief Valve
c - Thermal Relief Valve

THERMAL CIRCUIT BREAKER

If the "In"/"Down" or "Trailer" switch is kept depressed after drive unit reaches its end of travel, a thermal circuit breaker will open to prevent pump motor from overheating and pump motor will stop. Release switch(es) as soon as drive unit reaches end of travel to prevent this from happening. If circuit breaker should open, allow motor to cool down and circuit breaker will automatically reset.

MANUAL RELEASE VALVE (If Equipped) OPERATION

NOTE: Refer to "Special Information" (see "Index").

⚠WARNING

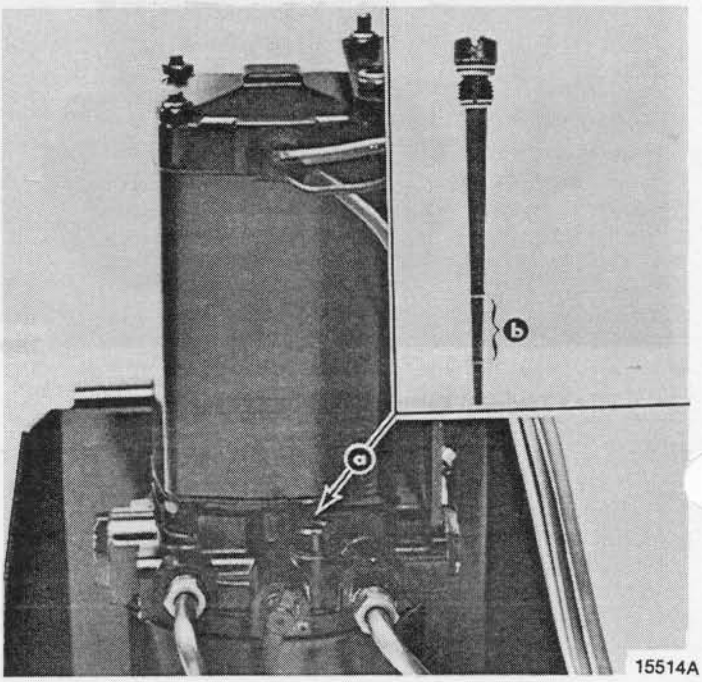
Before loosening manual release valve, make sure all persons are clear of stern drive unit as unit may drop to the full "In"/"Down" position if valve is opened too quickly.

In the case of a Power Trim system malfunction, the stern drive unit can be raised and lowered manually by turning the manual release valve (if equipped) counterclockwise approximately 3 turns and moving drive unit to desired position by hand. After drive unit has been placed in the desired position, close valve COMPLETELY. Power Trim system will not function properly and damage to valve "O" rings may result, unless valve is completely closed.

MAINTAINING POWER TRIM PUMP OIL LEVEL

1. Place stern drive unit in the full "In"/"Down" position
2. - Remove fill/vent screw. Wipe screw clean with a clean, lint-free cloth and reinstall - DO NOT THREAD INTO PUMP.
   - Remove fill/vent screw and note oil level. Oil level must be between the "ADD" and "FULL" marks on dipstick.
   - If necessary, add SAE 10W-30 or 10W-40 motor oil thru fill/vent screw hole to bring level up to "FULL" mark on dipstick. DO NOT OVERFILL.

   NOTE: In tropical areas, SAE 30 motor oil can be used.



a - Fill/Vent Screw
b - "FILL-ADD" Dipstick Markings Oildyne Power Trim Pump

3. Raise and lower drive unit 2 times to purge air from system; then, recheck oil level and add oil, if necessary.
4. Reinstall fill/vent screw by turning it all-the-way in; then, back out screw one (1) full turn.

⚠CAUTION

Fill/Vent screw MUST BE backed out one (1) full turn (after bottoming out) to vent pump reservoir. FAILURE TO BACK SCREW OUT COULD RESULT IN DAMAGE TO PUMP.

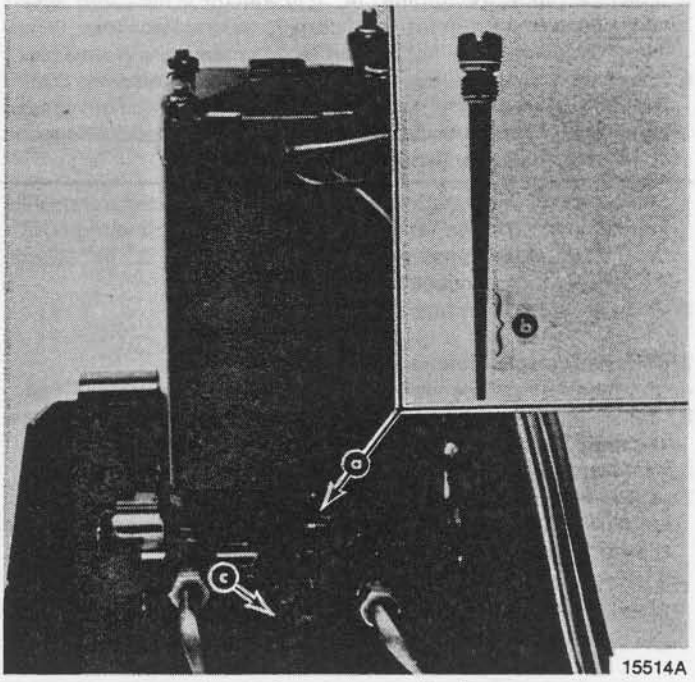
AIR BLEEDING POWER TRIM SYSTEM

The Power Trim system will purge itself of a small amount of air by raising and lowering the drive unit several times. However, if a rebuilt trim cylinder is being installed (which has not been filled with oil), the following bleeding procedure should be used to remove the air from the system.

1. With drive unit in the full "In"/"Down" position, remove fill/vent screw and fill trim pump to proper level (indicated on dipstick) with SAE 10W-30 or 10W-40 motor oil.

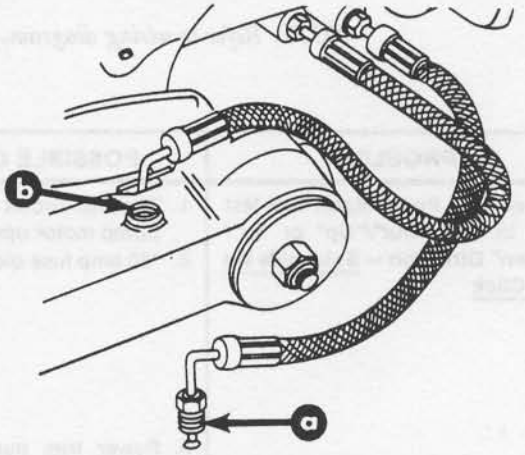
   NOTE: If both trim cylinders have been rebuilt, fill trim pump with oil to bottom of threads in fill/vent screw hole. This is necessary to prevent pump from running out of oil when bleeding system.

2. Make sure that manual release valve (if equipped) is completely closed (bottomed-out).



a - Fill/Vent Screw
b - "FULL" and "ADD" Marks
c - Manual Release Valve

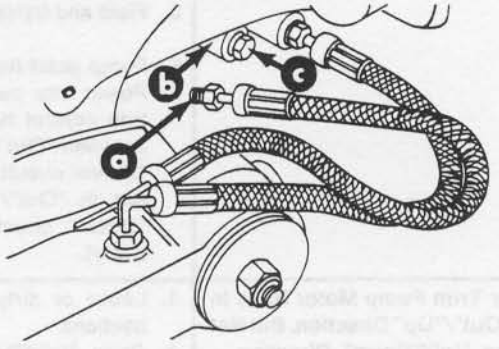
3. Disconnect "Out"/"Up" hose from front connection on rebuilt trim cylinder. If both cylinders were rebuilt, disconnect hose from both cylinders.



a - "Out"/"Up" Trim Hose
b - Front Connection On Trim Cylinder

Bleeding "Out"/"Up" Trim Circuit

4. Direct end of trim hose(s) into a container; then, run trim pump in the "Up" direction until a solid, air-free stream of oil is expelled from hose(s). Reconnect hose(s) and tighten securely.
5. Refill trim pump to proper level.
6. ● Disconnect "In"/"Down" trim hose (on side with rebuilt trim cylinder) from rear connection on gimbal housing hydraulic connector. If both cylinders were rebuilt, disconnect hose from aft connection on both sides of connector.
   ● Plug connector(s) in hydraulic connector, using plug (22-38609) or a suitable device.



a - "In"/"Down" Trim Hose
b - Hydraulic Connector
c - Plug (22-38609)

Bleeding "In"/"Down" Trim Circuit

7. Direct end of trim hose(s) into a container. Run trim pump in the "Up" direction until trim cylinders are fully extended.
8. Remove plug(s) from gimbal housing hydraulic connector and momentarily run trim pump in the "Down" direction until a solid stream of oil is expelled from connector. Reconnect trim hose(s) and tighten securely.
9. Lower drive unit to the full "In"/"Down" position and refill trim pump to proper level. Run trim system "In"/"Down" and "Out"/"Up" several times and recheck oil level.

TROUBLESHOOTING

TROUBLESHOOTING POWER TRIM ELECTRICAL SYSTEM

NOTE: Refer to wiring diagram, following, for assistance in electrical system troubleshooting.

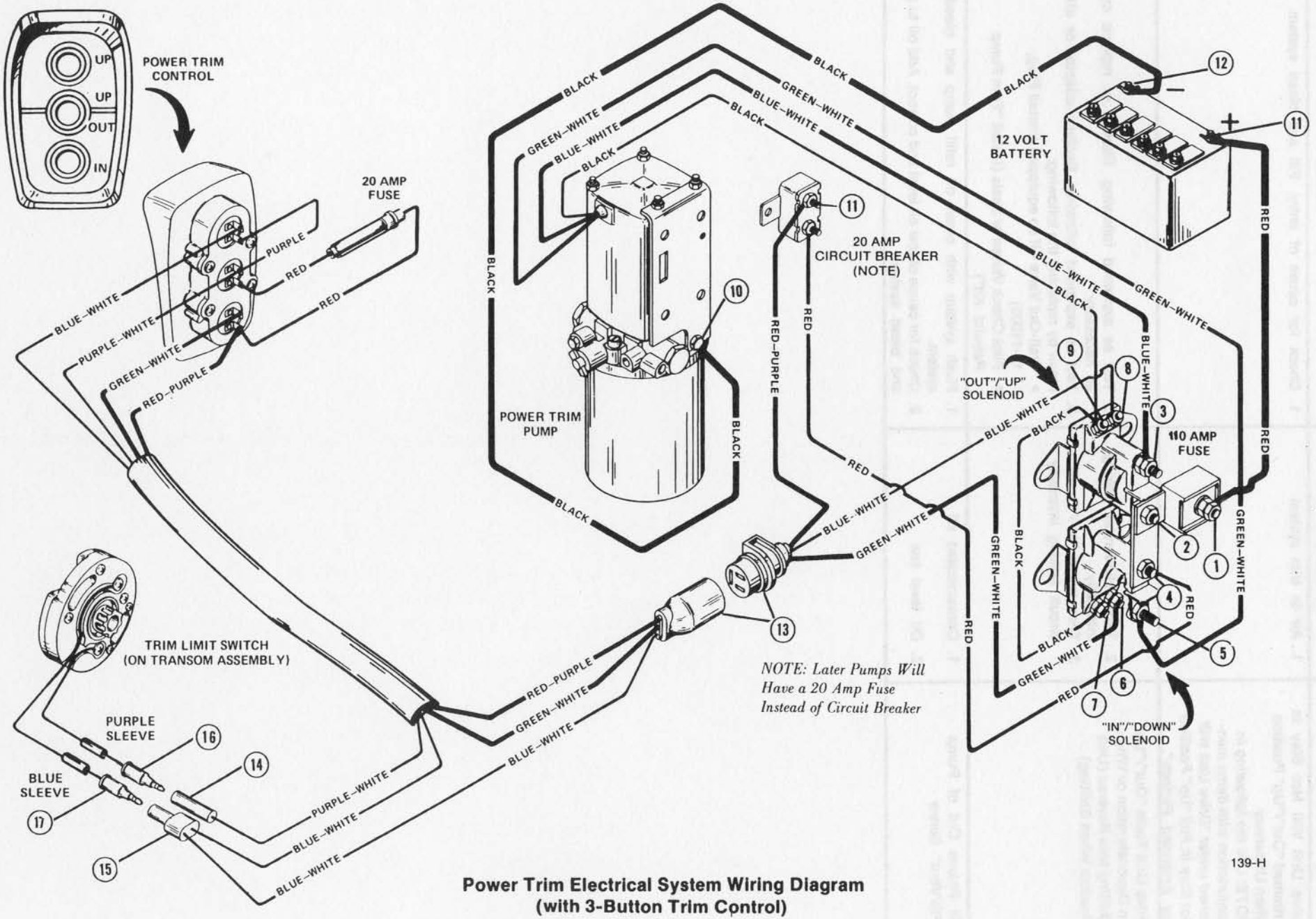
PROBLEM	POSSIBLE CAUSES	REMEDY
Power Trim Pump Motor Will Not Run in The "Out"/"Up" or "In"/"Down" Direction -- **Solenoids Do Not Click** *Does not apply to an intermittent problem.	1. Thermal circuit breaker in pump motor open. 2. *20 amp fuse blown. 3. Power trim pump battery cables or wiring harness connections corroded or loose. 4. Trim control wiring harness connector loose or corroded. 5. *110 amp fuse blown. 6. Open circuit in trim control wiring harness.	1. Replace commutator end plate assy. 2. Determine cause for blown fuse and correct before replacing fuse. *NOTE: If fuse blows while trimming "Out/"Up" or raising drive unit, problem may be due to grounded trim limit switch leads. To check for grounded condition, disconnect trim limit switch leads at bullet connector "14", "15", "16", and "17" (in wiring) diagram). If drive unit can now be raised (using "Trailer" switch), trim limit switch or leads are grounded.* 3. Clean and/or tighten connections "1", "2", "4", "10", "11" and "12", as necessary. 4. Clean and secure connection "13", as necessary. 5. Check for voltage at terminal "4". If no voltage is indicated, determine cause for blown fuse and correct, then replace fuse. (Trimming "Out"/"Up" and "In"/"Down" simultaneously will blow fuse.) 6. Check for battery voltage at terminal "8" while trimming "Out"/"Up" and at terminal "6" while trimming "In"/"Down". If no voltage is indicated, check trim control for a loose or corroded connection or a damaged power supply lead in harness.
Power Trim Pump Will Not Run In The "Out"/"Up" or "In"/"Down" Direction -- **Both Solenoids Click**	1. Faulty solenoids or loose or corroded connections. 2. Pump motor brushes stuck, corroded or worn out. 3. Armature commutator dirty. 4. Armature faulty. 5. Field and frame faulty. 6. Pump gears froze. 7. Power trim pump harness or trim control harness shorted between "Out"/"Up" and "In"/"Down" circuit (pump trying to run in "Out"/"Up" and "In"/"Down" direction simultaneously).	1. Check for battery voltage at terminal "5" (in wiring diagram) while trimming "In"/"Down" and at terminal "3" while trimming "Out"/"Up". If no voltage is indicated, check connections "2", "3", "4" and "5" and/or replace solenoids. 2. Clean or replace, as required. 3. Clean or replace armature, as required. 4. Test for shorted, open or grounded condition and replace if bad. 5. Check for open or grounded condition. Replace field and frame assembly, if bad. 6. Replace pump valve body and gear assembly. 7. Disconnect blue-white lead from solenoid terminal "8". If pump motor will now run in the "In"/"Down" direction, a short in harness exists. Repair or replace harness, as necessary.
Power Trim Pump Motor Runs In The "Out"/"Up" Direction, But Not In The "In"/"Down" Direction -- **"In"/"Down" Solenoid Does Not Click**	1. Loose or dirty solenoid connections. 2. Open "In"/"Down" circuit in trim control or pump wiring harness. 3. Solenoid faulty.	1. Check connections "6" and "7" (in wiring diagram) and clean and/or tighten, as required. 2. Check for battery voltage at terminal "6" while trimming "In"/"Down". If no voltage is indicated, check for a loose or corroded "In"/"Down" circuit connection, damaged "In"/"Down" circuit lead or a faulty "In"/"Down" trim switch. Repair or replace, as required. 3. Replace solenoid.

PROBLEM	POSSIBLE CAUSES	REMEDY
Power Trim Pump Motor Runs In The "Out"/"Up" Direction But Not In The "In"/"Down" Direction -- **"In"/"Down" Solenoid Clicks**	1. Loose or dirty solenoid connection. 2. Faulty solenoid. 3. Faulty "In"/"Down" field winding.	1. Check connections "4" and "5" (in wiring diagram). Clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "5" while trimming "In"/"Down". If no voltage is indicated, replace solenoid. 3. Replace field and frame assembly.
Power Trim Pump Motor Runs In "In"/"Down" Direction But Not "Out"/"Up" Direction (Both Trim and Trailer Switches Inoperative) - **"Out"/"Up" Solenoid Does Not Click**	1. Loose or dirty solenoid connections. 2. Open "Out"/"Up" circuit in trim control or pump wiring harness. 3. Solenoid faulty.	1. Check connections "8" and "9" (in wiring diagram). Clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "8" while trimming "Out"/"Up". If no voltage is indicated, check for a loose or corroded "Out"/"Up" circuit connection, blown fuse (if trim control is so equipped), damaged "Out"/"Up" circuit lead, or a faulty "Out"/"Up" trim switch. Repair or replace, as necessary. 3. Replace solenoid.
Power Trim Pump Motor Runs In "In"/"Down" Direction, But Not "Out"/"Up" Direction (Both Trim and Trailer Switches Inoperative) - **"Out"/"Up" Solenoid Clicks**	1. Loose or dirty solenoid connection. 2. Faulty solenoid. 3. Faulty "Out"/"Up" field winding.	1. Check connections "2" and "3" (in wiring diagram) and clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "3" while trimming "Out"/"Up". If no voltage is indicated, replace solenoid. 3. Replace field and frame assembly.
Trim Control "Out"/"Up" Trim Switch Inoperative - **Trailer Switch Operates**	1. Trim limit switch lead bullet connectors loose or corroded. 2. Trim limit switch or leads faulty. 3. Open in trim control "Out"/"Up" circuit.	1. Clean and/or tighten connections "14", "15", "16" and "17" (in wiring diagram), as necessary. 2. Disconnect trim limit switch leads from trim harness. Connect a continuity meter between leads "16" and "17". Continuity should be indicated with drive unit in full "In"/"Down" position. If not, check for damaged leads or poor connections. If this is not the cause, replace limit switch. 3. Check for a loose or corroded "Out"/"Up" circuit connection, damaged "Out"/"Up" circuit lead or faulty "Out"/"Up" trim switch. Repair or replace, as necessary.
Trim Control Trailer Switch Inoperative -- **Trim "Out"/"Up" Switch Functions**	1. Open in trim control trailer circuit.	1. Check for a faulty trailer switch, loose or corroded connections or damaged trailer circuit lead.
Trim System Functions While Unattended	1. Faulty trim or trailer switch. 2. Shorted trim pump harness or trim control harness.	1. Replace switch. 2. Repair or replace, as required.

TROUBLESHOOTING POWER TRIM HYDRAULIC SYSTEM

PROBLEM	POSSIBLE CAUSE	REMEDY
Drive Unit Cannot Be Trimmed "Out"/"Up" or Trims Slowly or With Jerky Movements	1. Power Trim pump oil level low	1. Check for cause of low oil level and correct. Add oil and bleed trim system.
	2. Air in trim system	2. Check for cause of entry and correct. Add oil to pump and bleed air from system.
	3. "O" rings damaged on Manual Release Valve (if equipped) or valve not completely closed	3. Replace valve and/or close completely.
	4. Insufficient pump pressure or pump shuttle valve stuck	4. Test, as exlpained following (use "Power Trim Pump Test"). If shuttle is stuck, replace pump adaptor. If pressure is low, replace adaptor or attempt to repair by replacing the following components: • "Out"/"Up" Pressure Relief Valve • Thermal Relief Valve
	5. Hoses reversed on one cylinder only	5. Connect hoses correctly.
	6. Trim cylinder(s) binding	6. Check for cause of binding (bent piston rod, scored cylinder, etc.). Repair or replace, as necessary.
	7. Gimbal housing-to-trim pump hydraulic hose pinched	7. Replace hose.
Drive Unit Cannot Be Lowered From "Up" Position or Lowers with Jerky Movements	1. Air in trim system	1. Check for cause of entry. Fill and bleed trim system.
	2. Damaged "O" rings on Manual Release Valve (If Equipped)	2. Replace valve.
	3. Insufficient "In"/"Down" pressure or shuttle valve stuck	3. Test, as explained preceding (use "Power Trim Pump Test"). If shuttle is stuck, replace pump adaptor. If pressure is low, replace adaptor or attempt to repair by replacing the following items: • "In"/"Down" Pressure Relief Valve • Trail-Out Valve - If So Equipped (Replace with Plug, 19-11005
	4. Trim cylinder(s) block leaking internally	4. Test, as explained following. Rebuild or replace cylinder, as necessary.
	5. Trim cylinder(s) binding	5. Check for cause of binding (bent piston rod, scored cylinder, etc.). Repair or replace, as necessary.
	6. Gimbal housing-to-trim pump hydraulic hose pinched	6. Replace hose.
	7. Hoses reversed on one trim cylinder only	7. Reconnect hoses correctly.
	8. Drive unit binding in gimbal ring	8. Check for cause of binding (bent gimbal ring, drive shaft housing, etc.) and replace.
Drive Unit Will Not Stay in Full "Up" Position For Extended Periods	1. External leakage	1. Check for cause and correct. Add oil to pump and bleed trim system.
	2. Damaged "O" rings on manual release valve (if equipped) or valve not closed completely	2. Replace valve and/or close completely.
	3. Pump "Out"/"Up" circuit leaking internally	3. Test, as explained following. Replace adaptor or attempt to repair by replacing the following: • Thermal Relief Valve • Pilot Check Valve or Seals (Install "Trim Pump Rebuild Kit")
	4. Trim cylinder(s) leaking internally and pump "Down" circuit leaking internally (both must be faulty to cause this problem)	4. Rebuild cylinders. Repair or replace adaptor as required.

PROBLEM	POSSIBLE CAUSE	REMEDY
Drive Unit Will Not Stay in Trimmed "Out"/"Up" Position When Underway *NOTE: Use the following in conjunction with items mentioned under "Drive Unit Will Not Stay In Full "Up" Position For Extended Periods".*	1. Air in trim system	1. Check for cause of entry. Fill and bleed system.
Drive Unit Trails "Out"/"Up" on Deacceleration or When Shifting Into Reverse (Unit Thumps When Shifting)	2. Trim cylinders(s) leaking internally 3. Trim pump "In"/"Down" circuit leaking internally	2. Test as explained following. Rebuild or replace cylinders, as necessary. 3. Test as explained following. Replace adaptor or attempt to repair by replacing the following: • Trail-Out Valve - If so equipped (Install Plug, 19-11005) • Pilot Check Valves or Seals (Install "Trim Pump Rebuild Kit")
Oil Foams Out of Pump "Fill/Vent" Screw	1. Contaminated oil 2. Oil level low	1. Flush system with clean oil refill pump and bleed trim system. 2. Check for cause of low oil level and correct. Add oil to pump and bleed system.

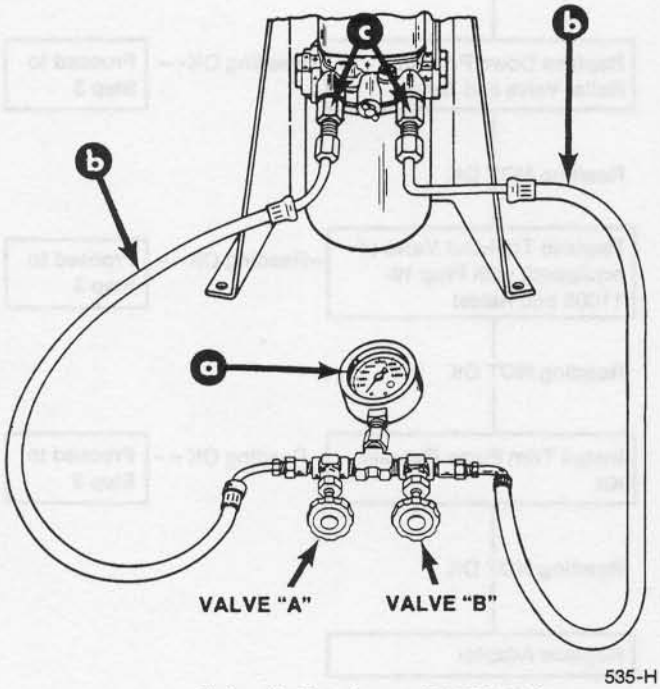


Power Trim Electrical System Wiring Diagram (with 3-Button Trim Control)

TESTING POWER TRIM and SYSTEM

POWER TRIM PUMP TEST

1. ● Check that "Manual Release Valve" (if equipped) is completely closed.
   ● Check trim pump oil level.
   ● Check for external leaks.
   ● Place drive unit in full "In"/"Down" position.
2. Connect test gauge at most convenient location.



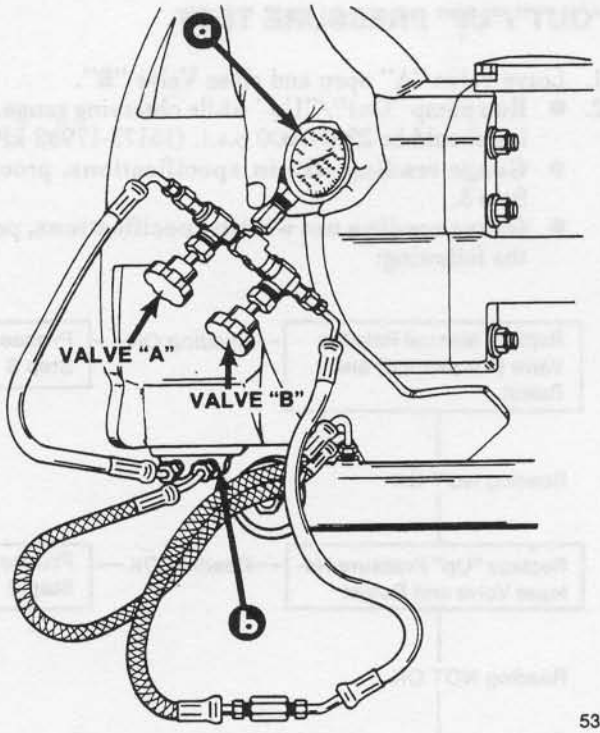
535-H

a - Hydraulic Test Gauge (91-52915A3)
b - Extension Hoses (32-87221A1)
c - Fittings (22-77366)

NOTE: Extension hoses MUST BE used to obtain accurate readings.

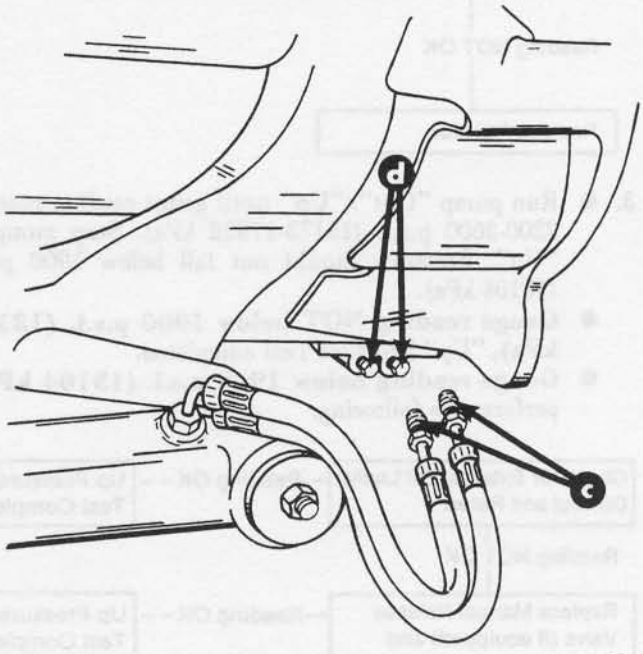
Gauge Connected to Pump

3. Open Valve "A" and "B" and run pump "Up" and "Down" several times (to purge air).



535-H

a - Hydraulic Test Gauge (91-52915A3)
b - Gimbal Housing Hydraulic Connector



535-H

c - Caps
d - Plugs
Supplied with Gauge

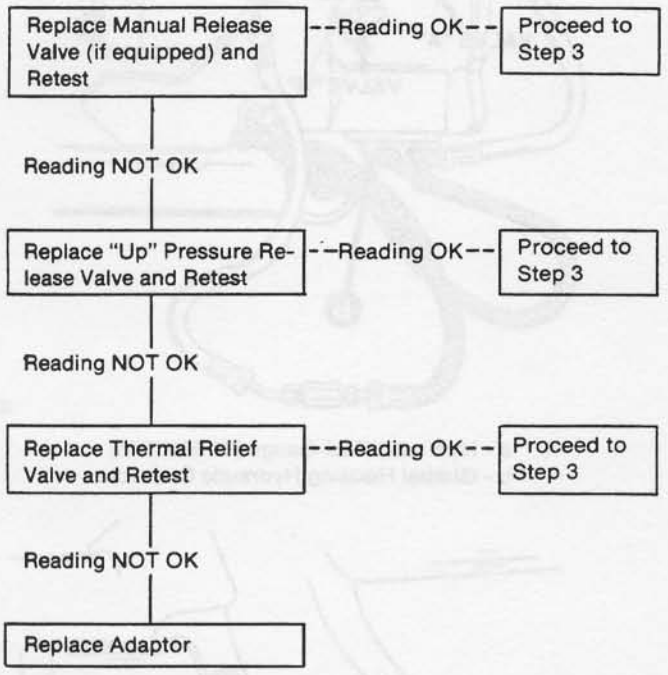
Gauge Connected to Hydraulic Connector

INTERNAL RESTRICTION (SHUTTLE VALVE) TEST

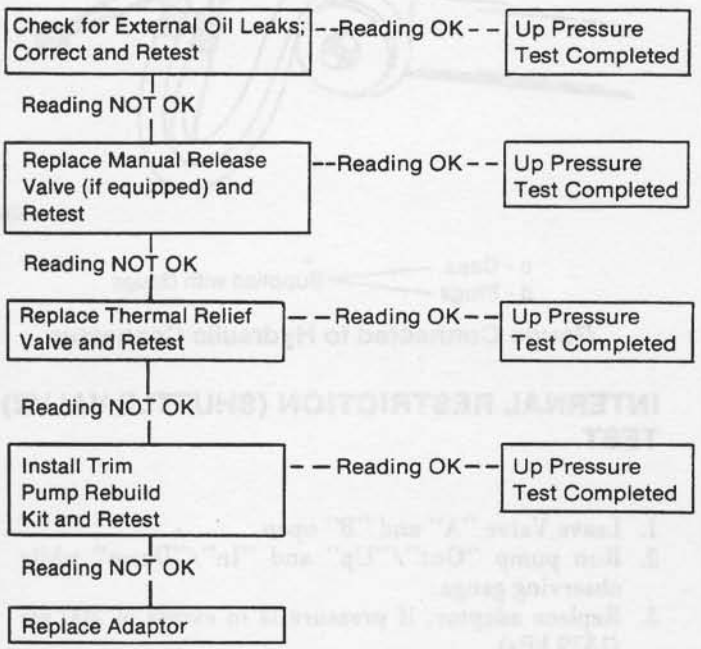
1. Leave Valve "A" and "B" open.
2. Run pump "Out"/"Up" and "In"/"Down" while observing gauge.
3. Replace adaptor, if pressure is in excess of 200 psi (1379 kPa).

"OUT"/"UP" PRESSURE TEST

1. Leave Valve "A" open and close Valve "B".
2. • Run pump "Out"/"Up" while observing gauge. Reading should be 2200-2600 p.s.i. (15173-17932 kPa).
   • **Gauge reading within specifications,** proceed to Step 3.
   • **Gauge reading not within specifications,** perform the following:

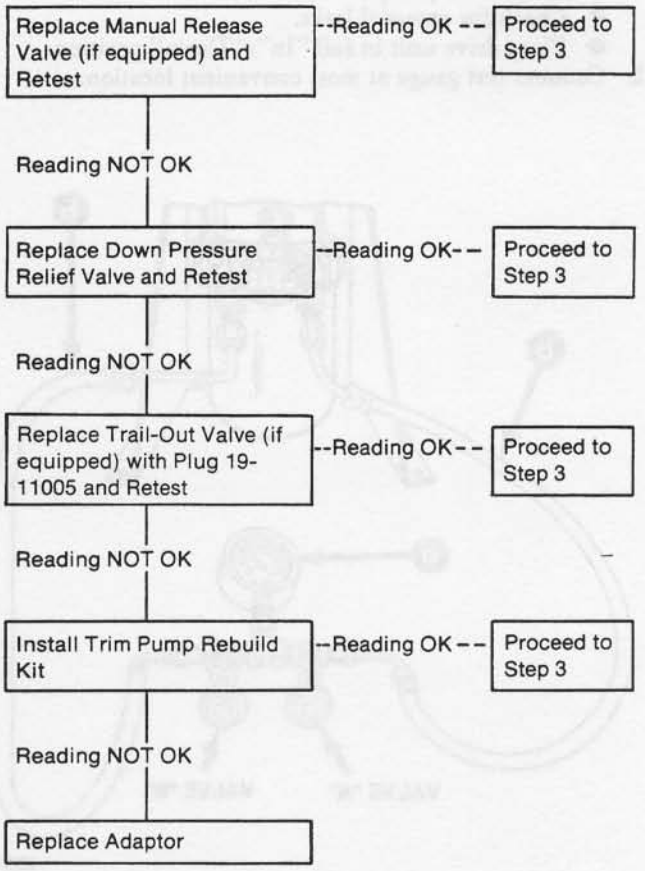


3. • Run pump "Out"/"Up" until gauge reading reaches 2200-2600 p.s.i. (15173-17932 kPa). Stop pumping "Up". Pressure should not fall below 1900 p.s.i. (13104 kPa).
   • **Gauge reading NOT below 1900 p.s.i. (13104 kPa),** "Up" Pressure Test completed.
   • **Gauge reading below 1900 p.s.i. (13104 kPa),** perform the following.

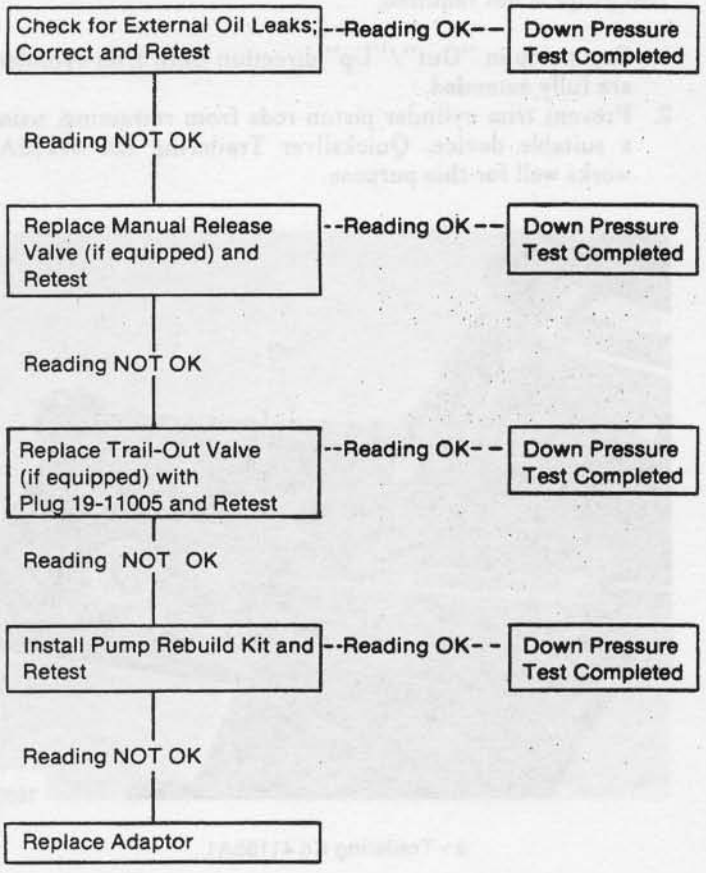


"IN"/"DOWN" PRESSURE TEST

1. Close Valve "A" and open Valve "B".
2. • Run pump "In"/"Down" while observing gauge. Reading should be 400-600 p.s.i. (2759-4138 kPa).
   • **Gauge reading within specifications,** proceed t Step 3.
   • **Gauge reading NOT within specifications,** perform the following:



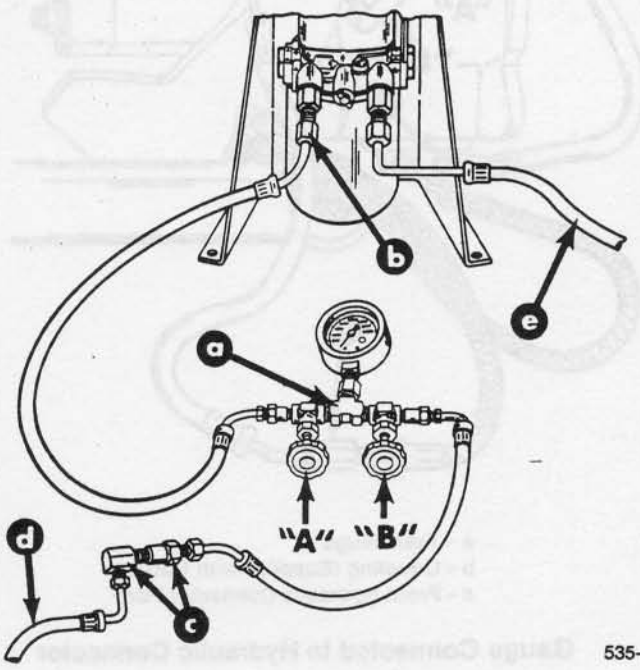
3. ● Run pump "In/Down" until gauge reading reaches 400-600 p.s.i. (2759-4138 kPa).
   Stop pumping "In"/"Down".
   Pressure should not fall below 350 p.s.i. (2414 kPa).
   - **Gauge reading above 350 p.s.i. (2414 kPa),** "Down" Pressure Test completed.
   - **Gauge reading below 350 p.s.i. (2414 kPa),** perform the following:



TRIM CYLINDER INTERNAL LEAK TEST

IMPORTANT: The following test assumes that pump "Out"/"Up" pressure is within specifications as determined by performing "Power Trim Pump Test".

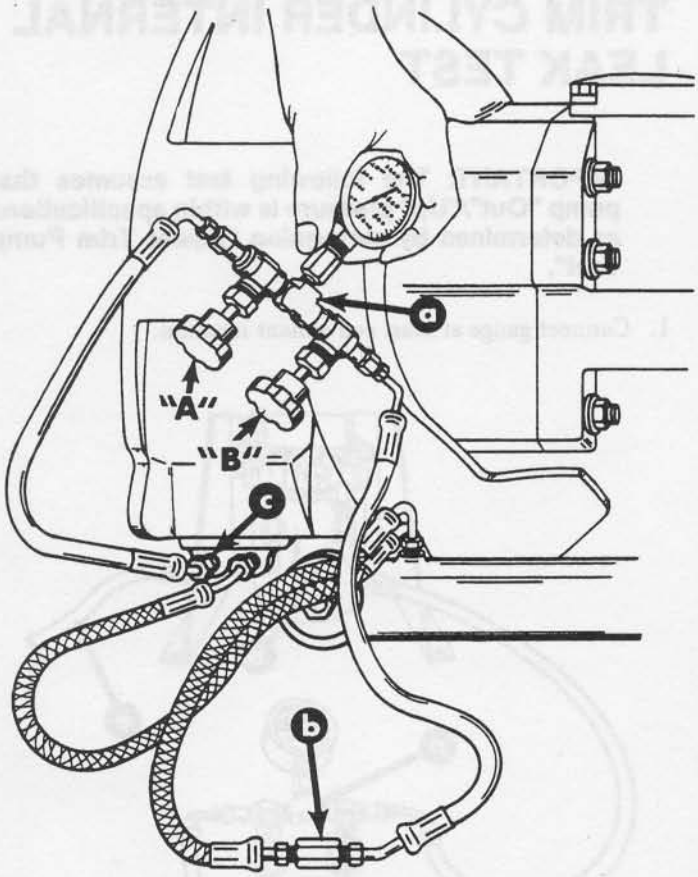
1. Connect gauge at most convenient location.



535-H

a - Hydraulic Test Gauge 91-52915A3
b - Fitting (22-77366)
c - Fittings (Supplied with Gauge)
d - Black Hydraulic Hose
e - Gray Hydraulic Hose
From Gimbal Housing

Gauge Connected at Pump



a - Test Gauge
b - Coupling (Supplied with Gauge)
c - Front Hydraulic Connector Port

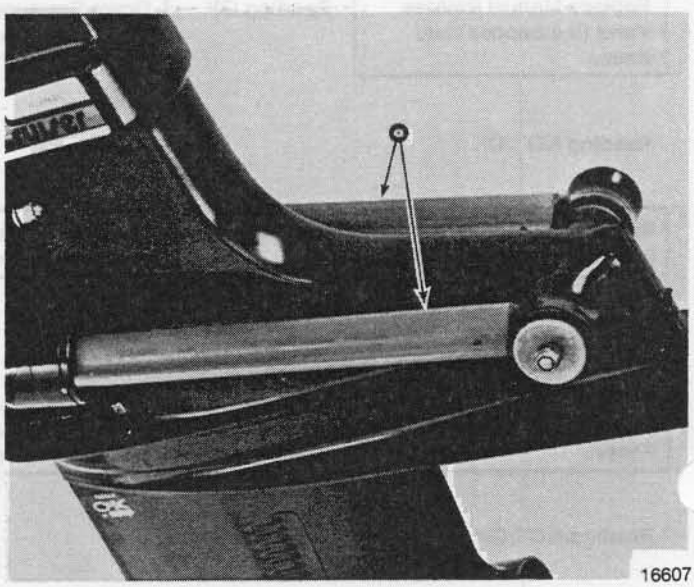
Gauge Connected to Hydraulic Connector

2. Open Valve "A" and "B" and run pump "Out"/"Up" and "In"/"Down"; several times (to purge air).
3. Run pump "Out"/"Up" until trim cylinders are fully extended; then, observe gauge while pumping. Pressure should be 2200-2600 psi (15173-17932 kPa).
4. Stop pumping "Out"/"Up". Pressure should not fall below 1900 psi (13104 kPa).
5. **If readings are not within specifications,** an internal trim cylinder leak is indicated. Use the following procedure to locate faulty cylinder.
   a. If gauge is connected at pump, reconnect gauge at gimbal housing hydraulic connector. Repeat Step 2; then, run pump in "Out"/"Up" direction until trim cylinder are fully extended.
   b. Close Valve "B" on test gauge and repeat Steps 3 and 4.
   - **If readings are now within specifications,** trim cylinder on same side of drive unit as gauge is faulty.
   - **If readings are still not within specifications,** trim cylinder on opposite side of drive unit as gauge is faulty.

TRIM CYLINDER SHOCK PISTON TEST

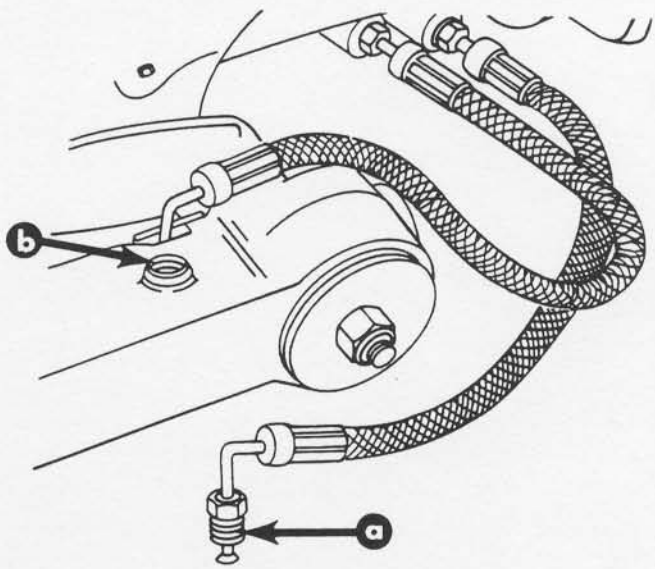
If trim system checks out good, but drive unit will not trim "In"/"Down", problem may be due to a leaky trim cylinder shock piston. Use the following test to check for this condition. Test gauge is not required.

1. Run pump in "Out"/"Up" direction until trim cylinders are fully extended.
2. Prevent trim cylinder piston rods from retracting, using a suitable device. Quicksilver Trailering Kit 41155A1 works well for this purpose.



a - Trailering Kit 41155A1

3. Disconnect "Up" trim hose from trim cylinders.



a - "Up" Trim Hose
b - Front Connection

4. Run pump in "In"/"Down" direction. If oil flows from "Up" port on trim cylinder, shock piston is leaking and must be replaced.

MOTOR and ELECTRICAL BENCH TESTS

TRIM PUMP MOTOR TEST

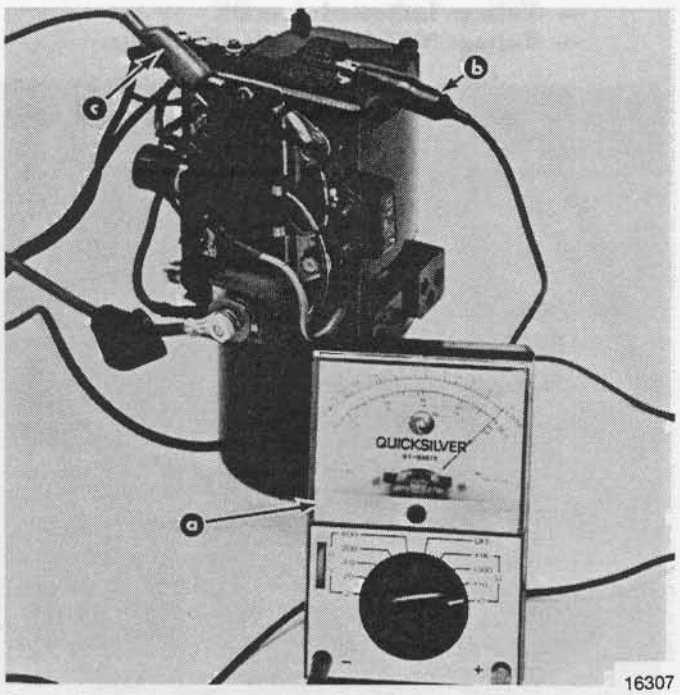
⚠WARNING

DO NOT perform this test near flammables (or explosives), as a spark may occur when making connections. Remove pump from boat, if necessary, before performing test.

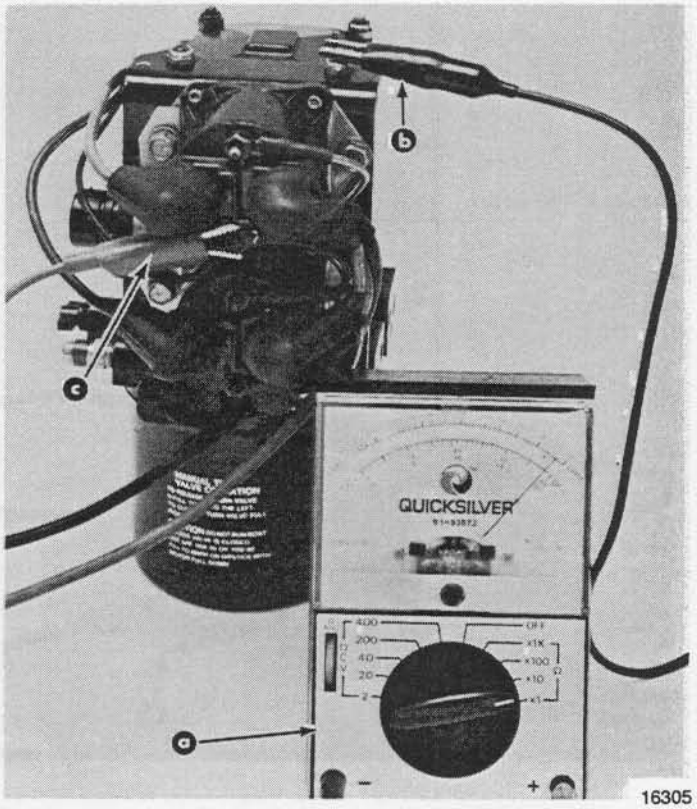
1. "Out"/"Up" Operation
   - Connect a 12 volt supply to large solenoid terminal (with blue-white motor lead attached). Connect negative supply lead to a good ground on pump. DO NOT connect to black motor lead.
2. "In"/"Down" Operation
   - Connect a 12 volt supply to large solenoid terminal (with green-white motor lead attached). Connect negative supply lead to a good ground on pump. DO NOT connect to black motor lead.
   - Motor should run.
3. If motor does not run, disassemble motor and check components. Refer to "Motor Repair", see "Index".

THERMAL OVERLOAD SWITCH TEST

1. Check thermal overload switch for continuity.



16307



16305

a - Ohmmeter-Set on Rx1 scale
b - Meter Lead-Connected to stud
c - Meter Lead-Connected to solenoid ground lead terminal

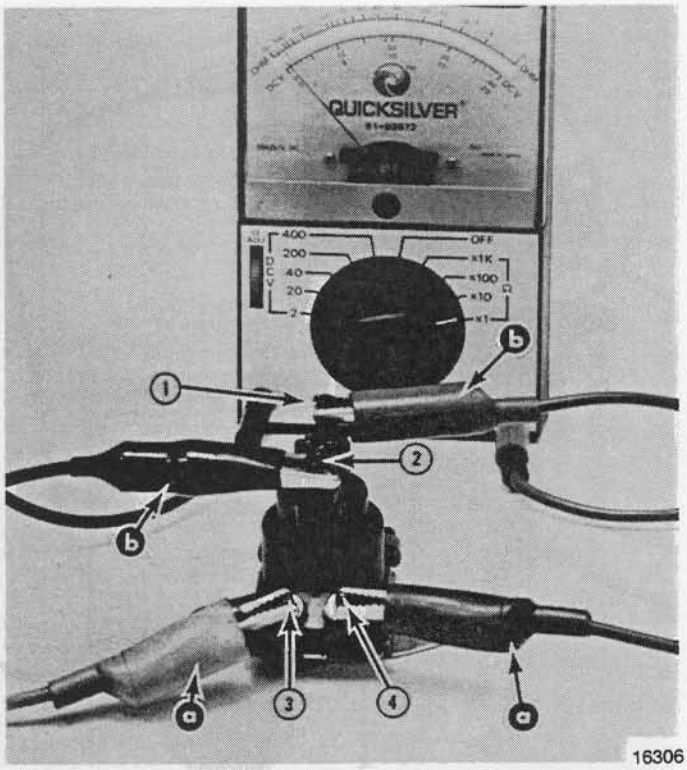
2. **Continuity indicated** - switch ok
   No continuity indicated replace field and frame assembly.

SOLENOID TEST

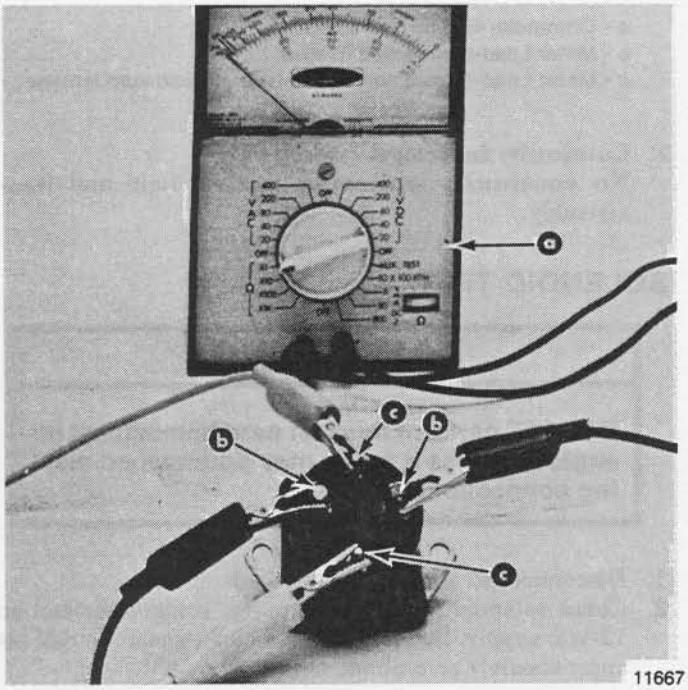
⚠WARNING

DO NOT perform this test near flammables (or explosives), as a spark may occur when making connections.

1. Disconnect all wires from solenoid.
2. Check solenoid for full continuity, using ohmmeter and 12-volt supply. Solenoid should click - meter should read approximately zero ohms.



16306



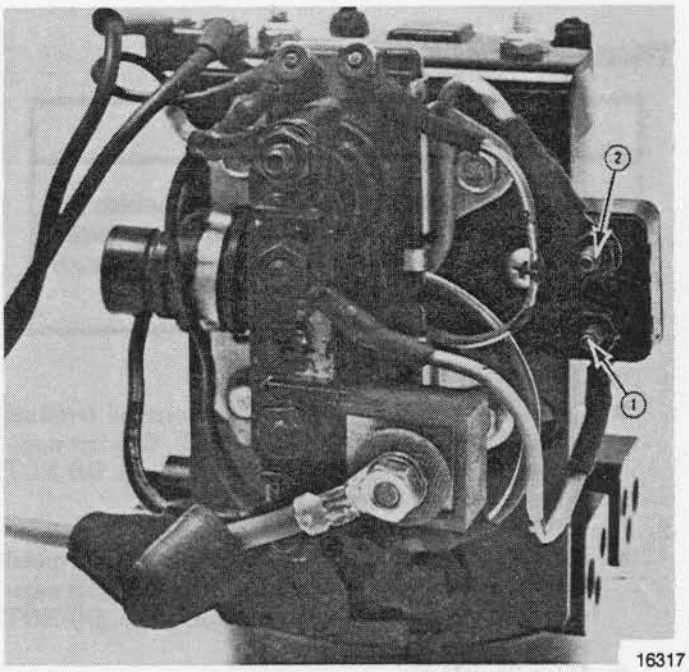
11667

a - Ohmmeter - Rx1 Scale
b - Ohmmeter Leads
c - 12-Volt Supply (Leads)

3. **Zero ohms read (full continuity)** - solenoid OK.
   High ohm reading (no continuity) - replace solenoid.

CIRCUIT BREAKER TEST

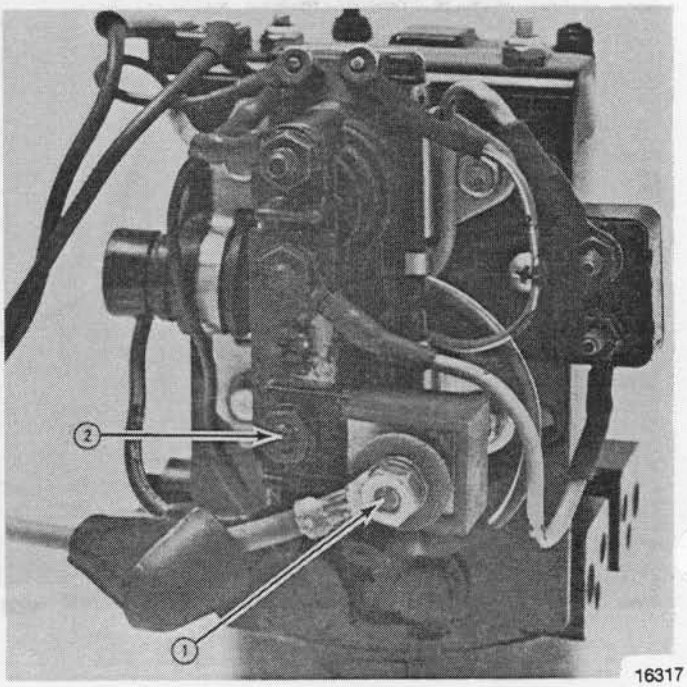
1. ● Check that reset tab is pushed in.
   ● Check for voltage at terminal "1", using a voltmeter. Voltage MUST BE indicated before proceeding with next check.
   ● Check for voltage at terminal "2", using a voltmeter.
   — **Voltage indicated:** breaker OK
   — **Voltage NOT Indicated**: replace breaker.



16317

FUSE TEST

- Check for voltage at terminal "1", using a voltmeter. Voltage MUST BE indicated before proceeding with next check.
- Check for voltage at terminal "2", using a voltmeter.
  — **Voltage Indicated:** fuse OK
  — **Voltage NOT Indicated:** replace fuse.

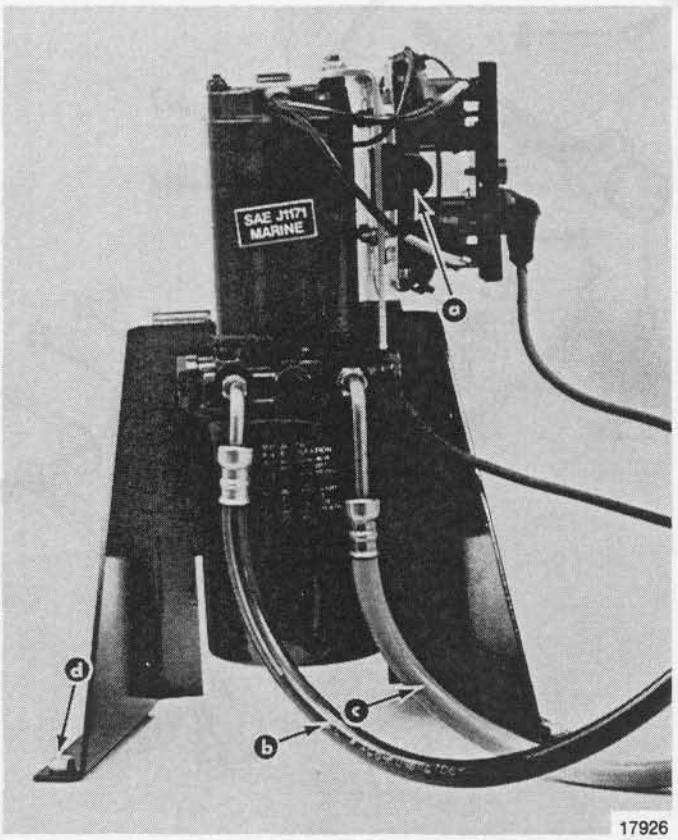


16317

TRIM PUMP REMOVAL and INSTALLATION

REMOVING TRIM PUMP FROM BOAT

1. ● Disconnect trim pump battery leads from battery (negative lead first).
   ● Disconnect trim harness connector (3 pronged) from trim pump.
   ● Remove trim hoses from pump. Cap ends of hoses.
   ● Remove lag bolts and washers, and lift pump and mounting bracket from boat.

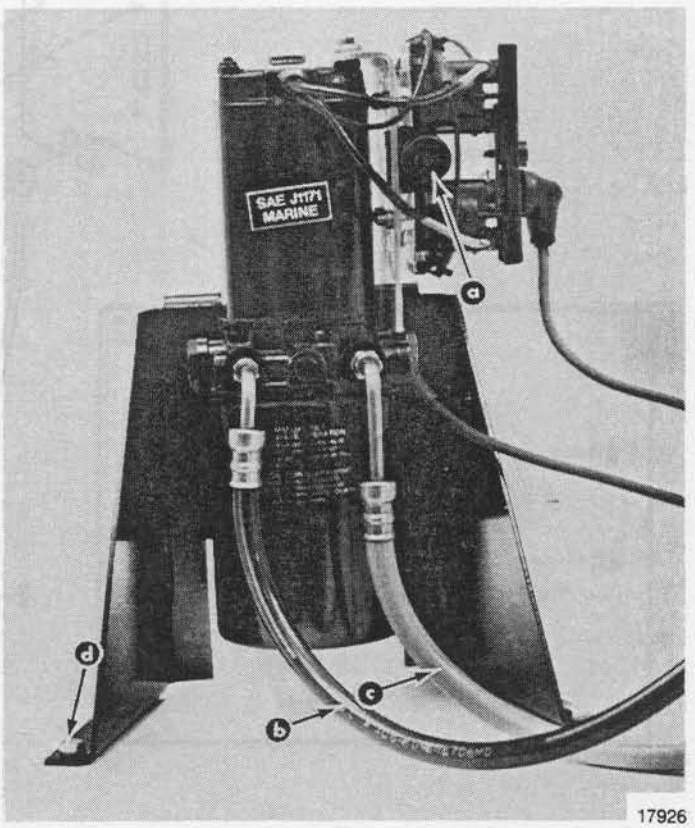


a - Harness Connector
b - Black Hydraulic Hose
c - Gray Hydraulic Hose
d - Lag Bolts and Washers

From Gimbal Housing

INSTALLING TRIM PUMP

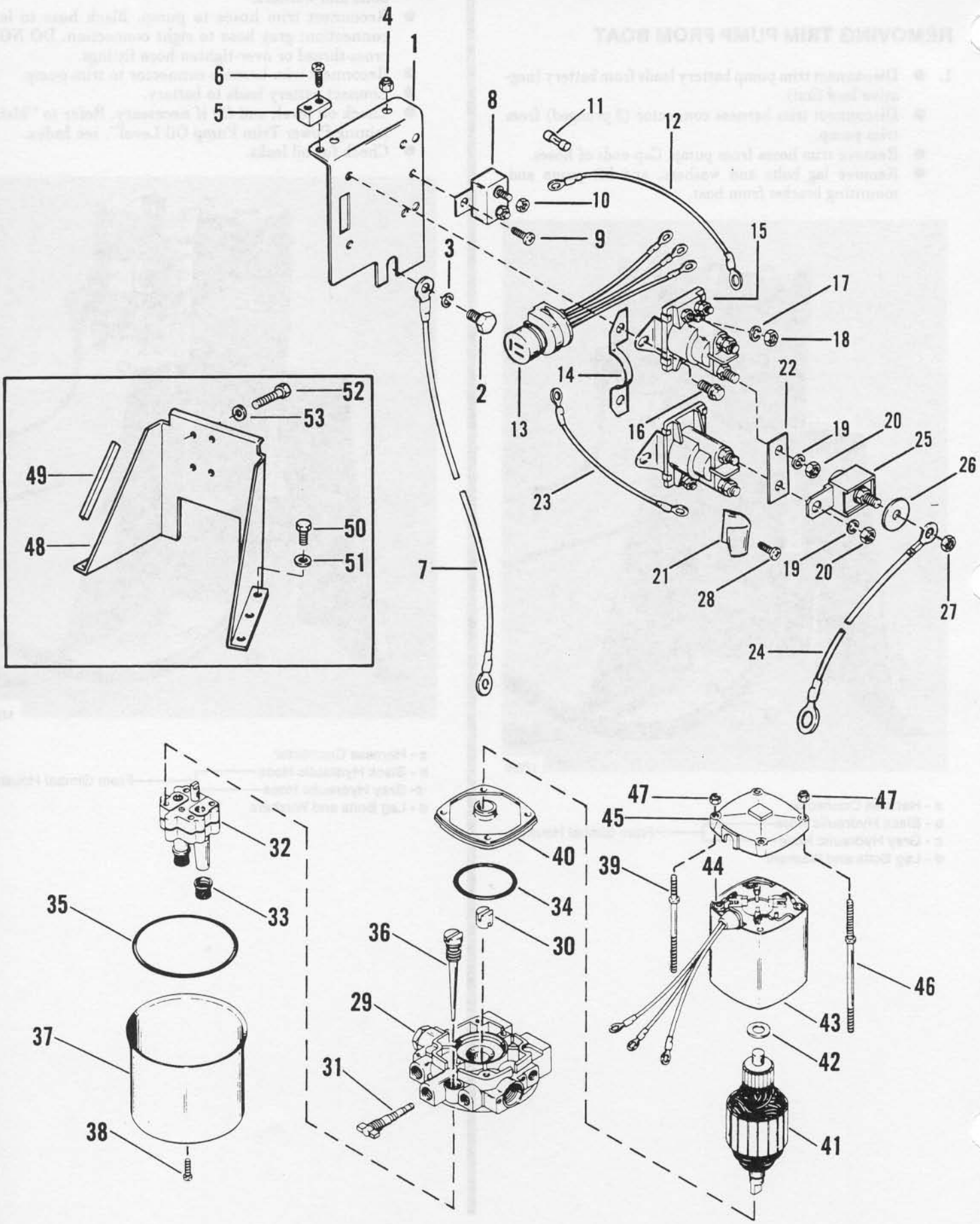
1. ● Secure pump and mounting bracket to boat, using lag bolts and washers.
   ● Reconnect trim hoses to pump. Black hose to left connection; gray hose to right connection. DO NOT cross-thread or over-tighten hose fittings.
   ● Reconnect trim harness connector to trim pump.
   ● Connect battery leads to battery.
   ● Check oil level, and fill if necessary. Refer to "Maintaining Power Trim Pump Oil Level", see Index.
   ● Check for oil leaks.



a - Harness Connector
b - Black Hydraulic Hose
c- Gray Hydraulic Hose
d - Lag Bolts and Washers

From Gimbal Housing

OILDYNE POWER TRIM PUMP - EXPLODED PARTS VIEW



1 - BRACKET, mounting - solenoid
2 - SCREW, mounting bracket (5/8")
3 - WASHER, mounting bracket screw
4 - NUT, mounting bracket to hydraulic pump
5 - TERMINAL BLOCK
6 - SCREW, wire to terminal block (7/16")
7 - BATTERY CABLE, black (negative)
8 - CIRCUIT BREAKER (20 Amp.)
9 - SCREW, circuit breaker
10 - NUT, circuit breaker terminal
11 - FUSE (20 Amp.)
12 - WIRE, solenoid to solenoid (red)
13 - HARNESS ASSEMBLY, hydraulic pump
14 - RETAINER, harness to mounting bracket
15 - SOLENOID
16 - SCREW, solenoid to bracket (3/8")
17 - LOCKWASHER, solenoid terminal (#8)
18 - NUT, starter terminal (#8-32)
19 - LOCKWASHER, solenoid terminal (1/4")
20 - NUT, solenoid terminal (1/4-20)
21 - BOOT, rubber - starter solenoid terminal
22 - LINK, solenoid to solenoid
23 - WIRE, solenoid to solenoid (black)
24 - BATTERY CABLE, red (positive)
25 - FUSE (110 Amp.)
26 - WASHER, fuse terminal
27 - NUT, fuse terminal
28 - SCREW, solenoid insulator
29 - ADAPTOR
30 - COUPLING
31 - MANUAL RELEASE (Includes 3 "O" Rings) If Equipped
32 - PUMP (Includes Screws)
33 - FILTER
34 - "O" RING, motor end
35 - "O" RING, reservoir end
36 - DIPSTICK
37 - RESERVOIR
38 - SCREW, reservoir (Includes "O" Ring)
39 - THRU STUD (Short)
39 - THRU STUD (Long)
40 - END FRAME, drive end
41 - ARMATURE
42 - WASHER, thrust-armature
43 - FIELD and FRAME
44 - BRUSH CARD
45 - END FRAME, commutator end
46 - THRU BOLT, motor (Short)
46 - THRU BOLT, motor (Long)
47 - NUT, thru bolt and stud
48 - BRACKET ASS'Y, mounting-hyd. pump (floor mounted)
49 - BUMPER, rubber-pump mounting bracket
50 - SCREW, hydraulic pump to mounting bracket
51 - WASHER, pump mounting bracket screw
52 - SCREW, hydraulic pump to mounting bracket
53 - LOCKWASHER, hydraulic pump screw

HYDRAULIC REPAIR

⚠CAUTION

Work area must be dirt-and-lint free. The slightest amount of dirt in hydraulic system can cause pump malfunction.

MANUAL RELEASE VALVE REPLACEMENT (If Equipped)

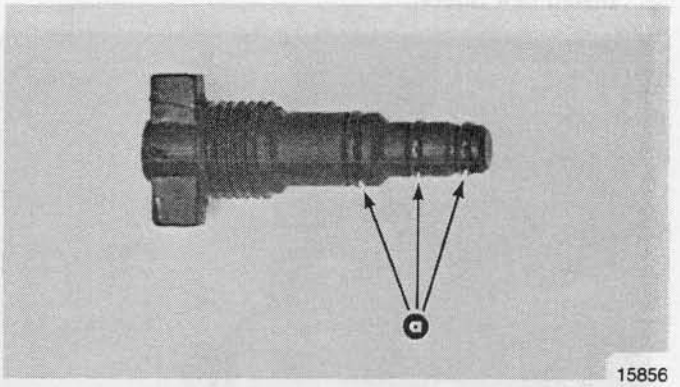
NOTE: Refer to "Special Information" (see "Index")

NOTE: Replacement of manual release valve can be completed without removing the trim pump from boat.

⚠WARNING

Before loosening the manual release valve, make sure all people are clear of drive unit as drive unit will drop to full "In"/"Down" position when valve is loosened.

- Inspect manual release valve for damaged "O" rings, and replace valve if necessary.
- Slowly turn manual release valve counterclockwise to remove. To install new valve, turn valve clockwise until it seats.

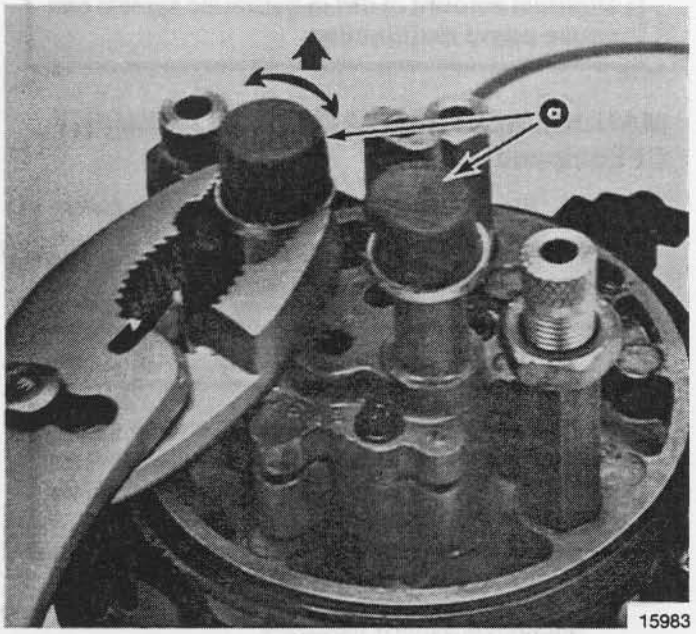


a - "O" Rings (3)

- "O" ring damage may result from the following:
  a. Operation of the Power Trim pump with the "Manual Release Valve" partially open. **Valve Must Be Completely Closed (Turned Clockwise Until Bottomed-Out) When Trimming "IN"/"Down" or "Out"/"Up"** Tighten valve finger-tight only -- DO NOT USE A PLIERS.
  b. Opening "Manual Release Valve" quickly with stern drive unit in the fully raised position. **Valve Must Be Opened SLOWLY to Gradually Relieve Pressure On System.**
  c. Continuous use of "Manual Release Valve". **Valve Is Designed for Emergency (Limited) Use Only.**

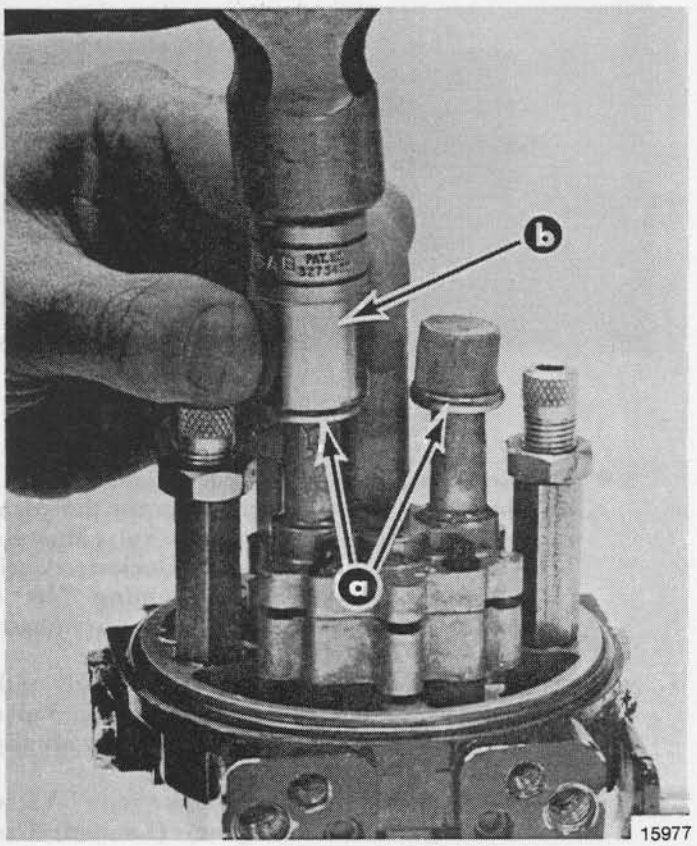
FILTER REPLACEMENT

1. Place a container under reservoir and remove oil reservoir from adaptor.
2. Remove filters as shown.



a - Filters

3. Install new filters.



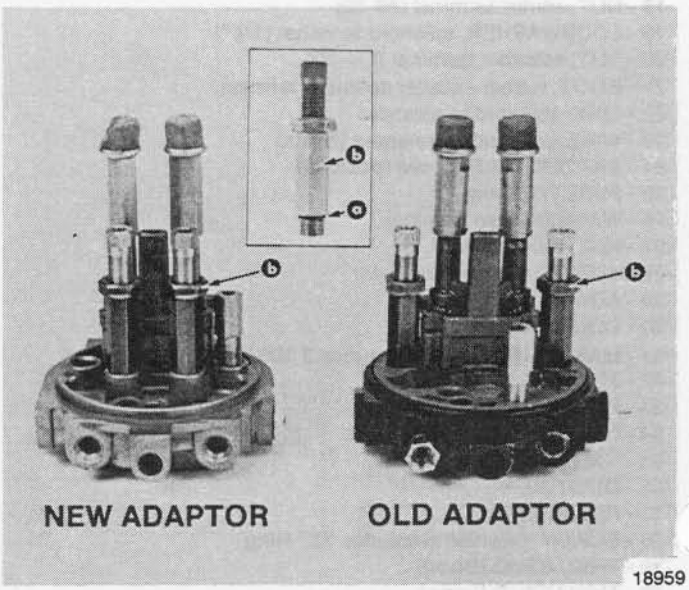
a - Filters
b - 5/8 In. Socket

4. Install oil reservoir "O" ring and oil reservoir.
5. Reinstall Power Trim pump in boat.
6. Fill reservoir with oil and bleed air from system. Refer to "Maintaining Power Trim Pump Oil Level".

"UP" PRESSURE RELIEF VALVE

IMPORTANT: DO NOT loosen nor attempt to remove hex "jam" nut. This valve is pre-set at the factory for proper "Up" pressure relief.

1. Replace "Up" pressure relief valve. Be sure that threaded valve hole is clean and free of foreign matter.

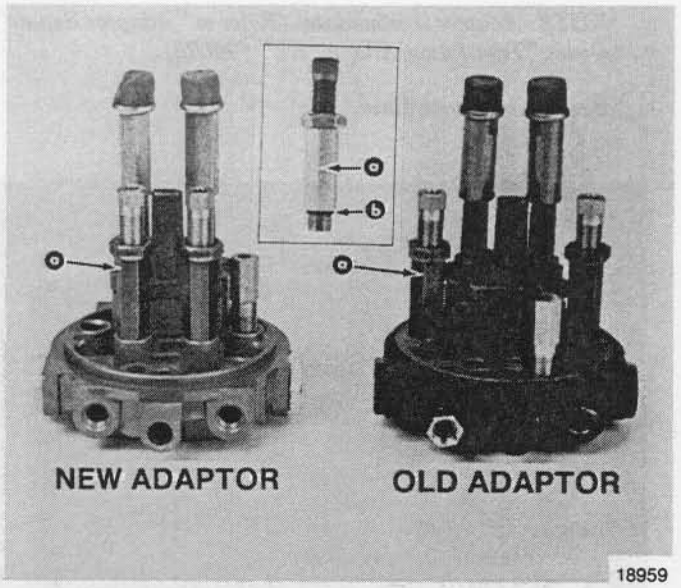


a - "O" Ring
b - "Up" Pressure Relief Valve - Tighten Securely

"DOWN" PRESSURE RELIEF VALVE

IMPORTANT: DO NOT loosen nor attempt to remove hex "jam" nut. This valve is pre-set at the factory for proper "Down" pressure relief.

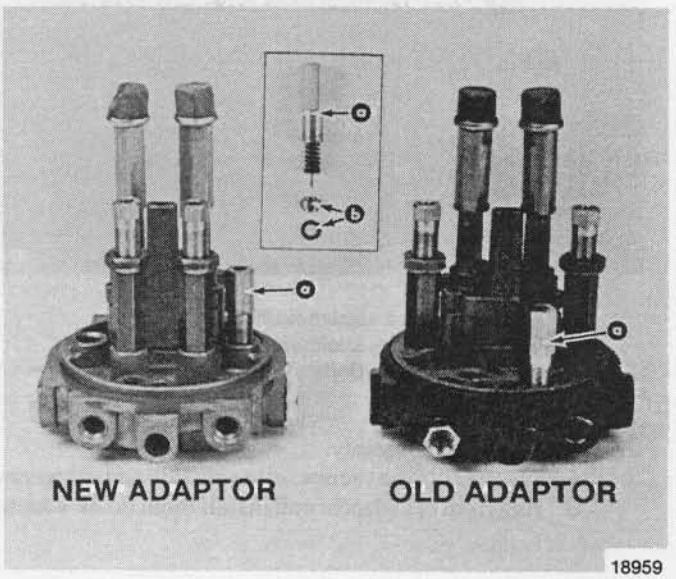
1. Replace "Down" pressure relief valve. Be sure that threaded valve hole is clean and free of foreign matter.



a - "Down" Pressure Relief Valve - Tighten Securely
b - "O" Ring

THERMAL RELIEF VALVE

1. Replace thermal relief valve. Be sure that threaded valve hole is clean and free of foreign matter.

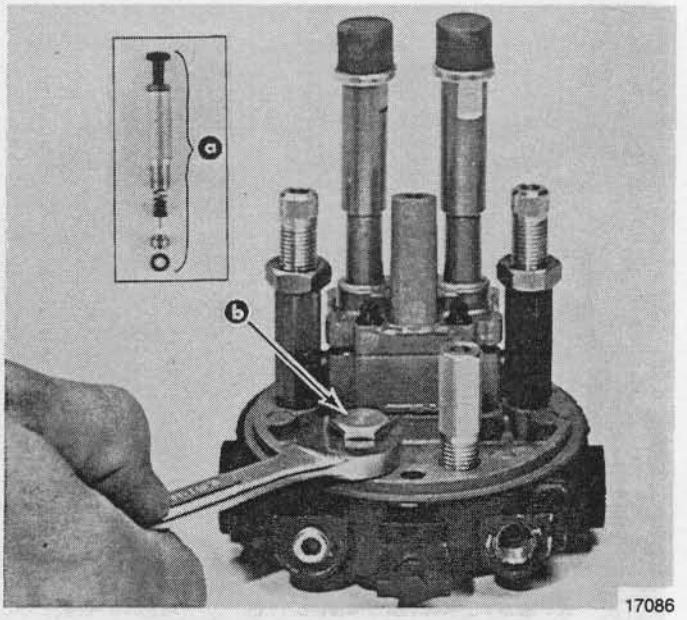


a - Thermal Relief Valve - Tighten Securely
b - "O"Ring - Large Ring in Bottom of Threaded Valve Hole
"O"Ring - Small Ring in New Valve Seal

REPLACEMENT PLUG - TRAIL-OUT VALVE

NOTE: Refer to "Special Information" (see "Index").

1. Install replacement plug with "O" ring. Be sure that threaded valve hole is clean and free of foreign material.

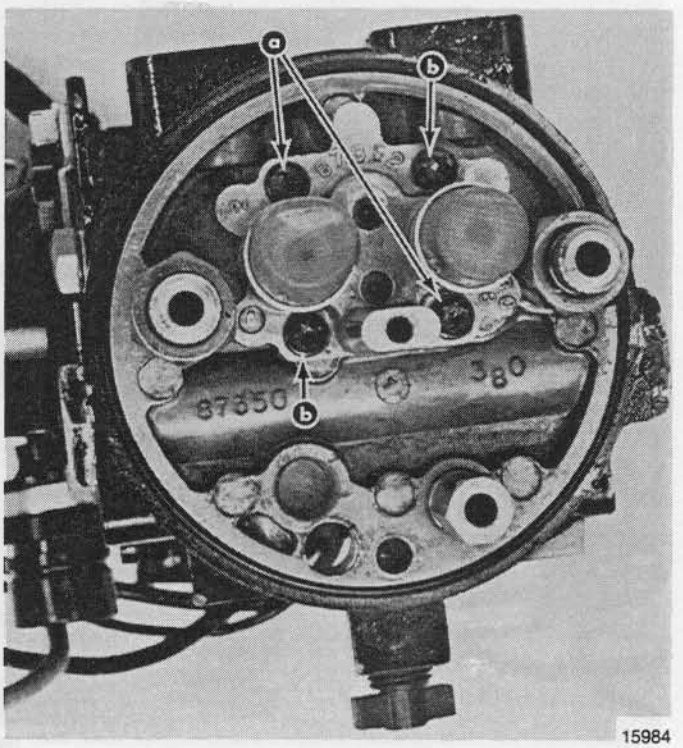


a - Remove and Discard Trail-Out Valve Assembly
b - Replacement Plug and "O" Ring - Tighten Securely

PUMP REPLACEMENT

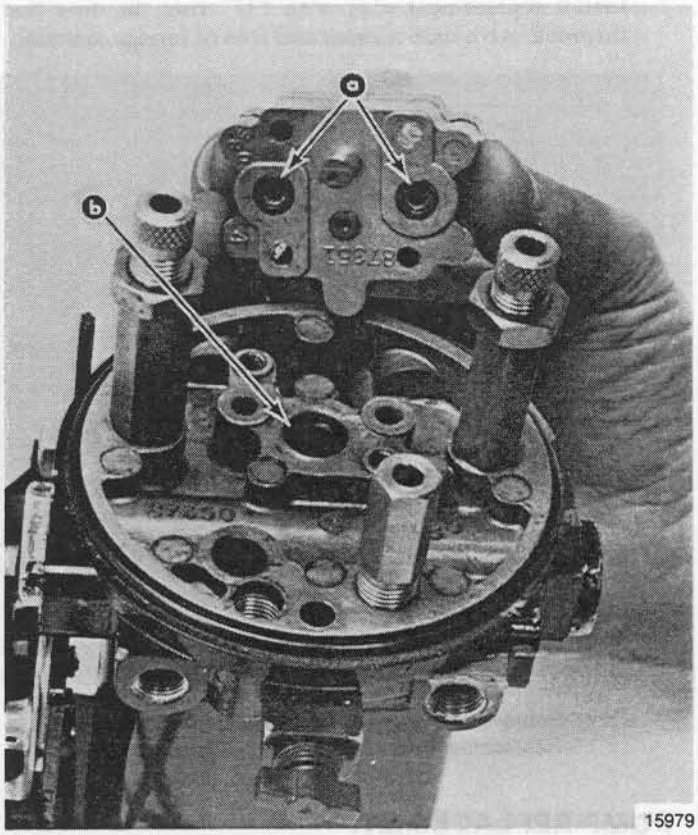
NOTE: The pump is not rebuildable. If pump is defective, replace as an assembly.

1. Remove oil reservoir from pump adaptor.
2. Remove pump attaching screws and pump.



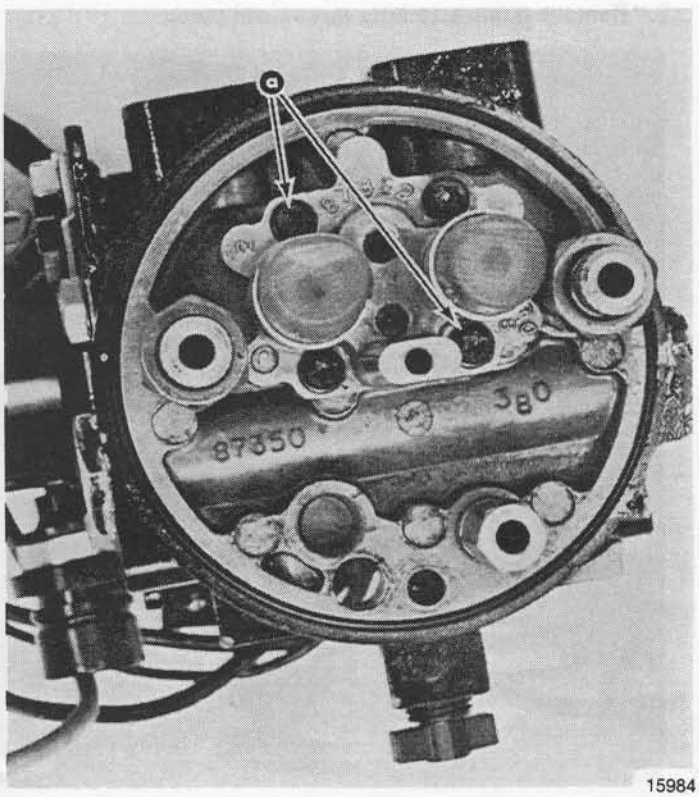
a - Remove Screws - Use a Torx Socket or 3/16 In. Socket
b - DO NOT Loosen

3. ● Remove "O" rings from old pump and install on new pump.
   ● Lubricate lip of adaptor seal with lightweight oil.



a - "O" Rings
b - Adaptor Seal

4. Install pump.



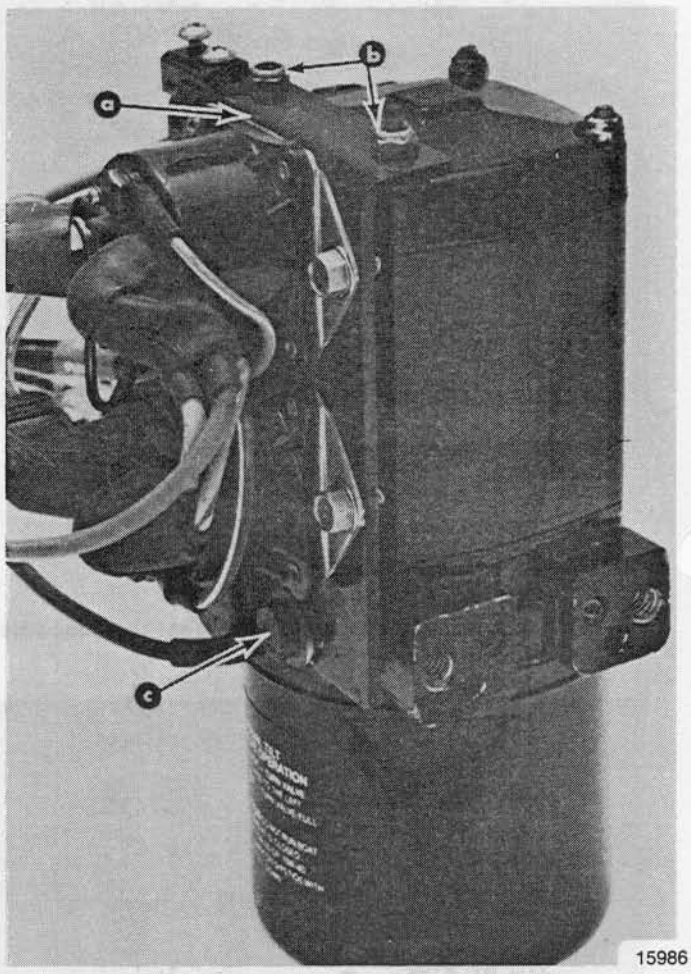
a - Screws - Torque to 75 Lbs. In. (8 N.m)

5. Install oil reservoir "O" ring, and oil reservoir.
6. Reinstall Power Trim pump assembly in boat.
7. Fill reservoir with oil and bleed air from system. Refer to "Maintaining Power Trim Pump Oil Level" and "Air Bleeding Power Trim System", see "Index".

ADAPTOR REPLACEMENT

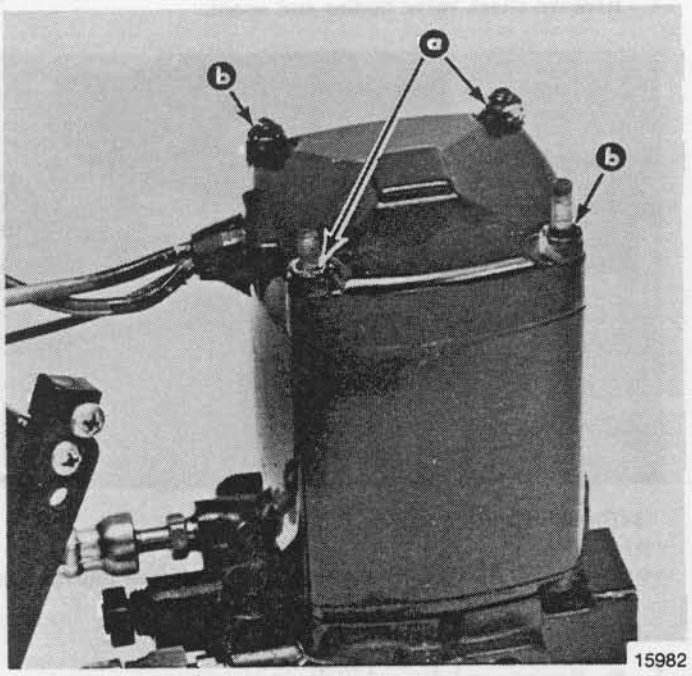
NOTE: Adaptor is rebuildable (Refer to "Adaptor Repair"). Order "Trim Pump Adaptor Kit" (99073).

1. Remove solenoid plate.



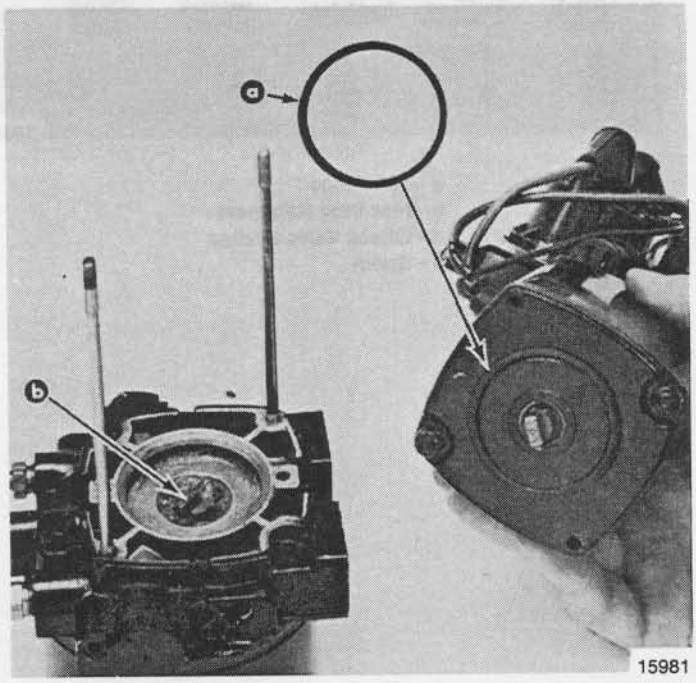
a - Solenoid Plate
b - Locknuts
c - Bolts

2. Remove motor assembly.
3. Remove the fill/vent screw, oil reservoir and oil reservoir "O" ring from old adaptor and install them on new adaptor.



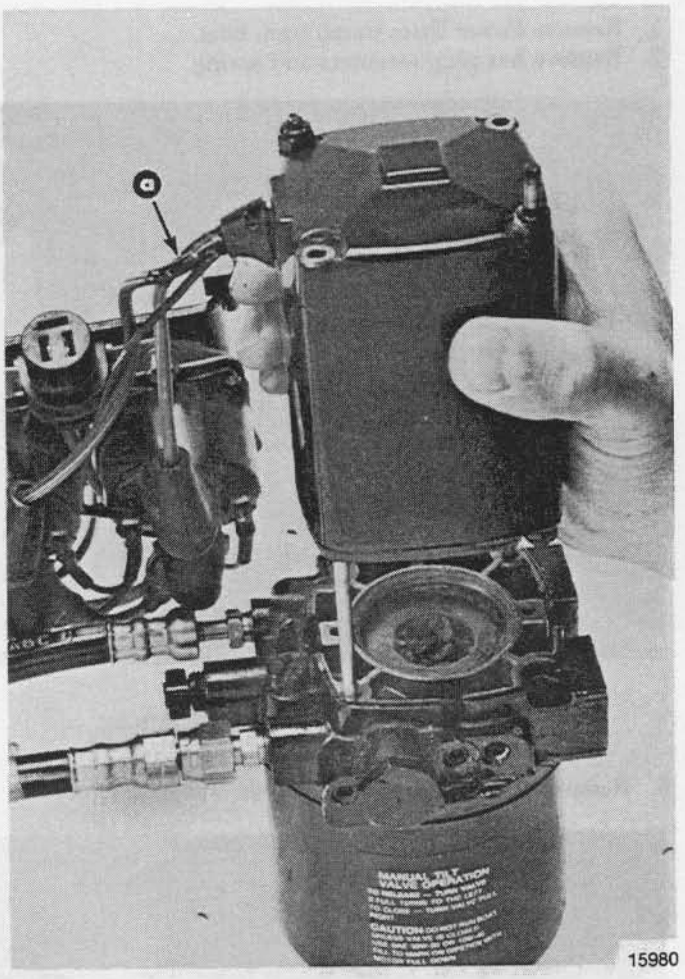
a - Remove Locknuts (Studs May Turn Out)
b - DO NOT Loosen

4. ● Remove "O" ring, coupling, and studs from old adaptor and install in new adaptor. Install new "O" ring on motor.
   ● Install coupling with shallow slot toward oil reservoir.
   ● Lubricate coupling with 2-4-C Multi-Lube.



a - "O" Ring
b - Coupling (Shallow Slot Toward Oil Reservoir)

5. Align motor shaft with coupling and install motor onto adaptor. Motor assembly will be flush with adaptor when shaft alignment is correct.



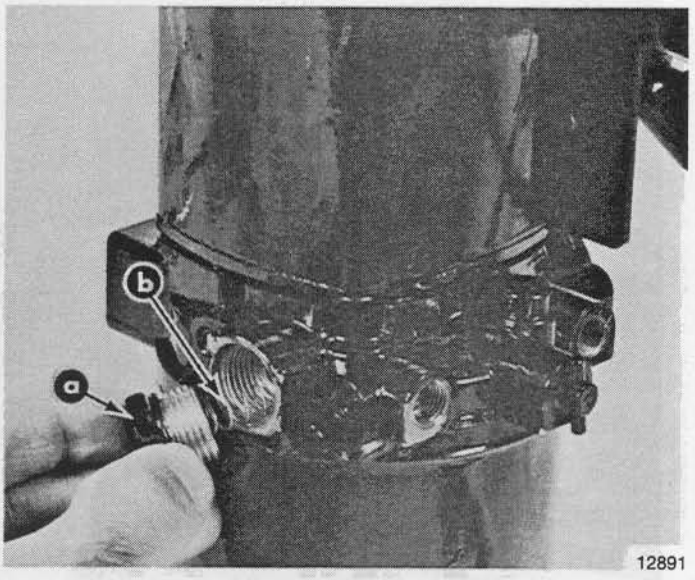
a - Position Wires to Side of Pump Shown

6. Secure motor assembly to adaptor with 2 locknuts.
7. Slide solenoid plate onto studs and secure with 2 locknuts and screw.
8. Reinstall pump in boat.
9. Fill reservoir with oil and bleed air from system. Refer to "Maintaining Power Trim Pump Oil Level" (see "Index").

ADAPTOR REPAIR

Internal "O" Ring and Poppet Valve Replacement

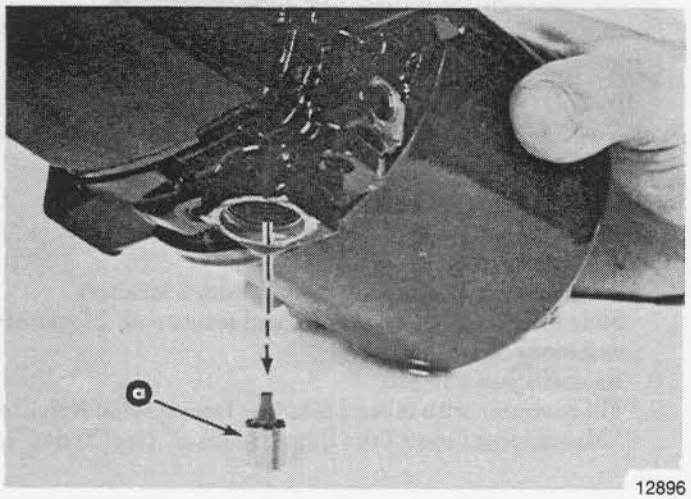
1. Remove Power Trim pump from boat.
2. Remove hex plug retainers and spring.



12891

a - Hex Plug Retainers (2)
b - Springs (2)

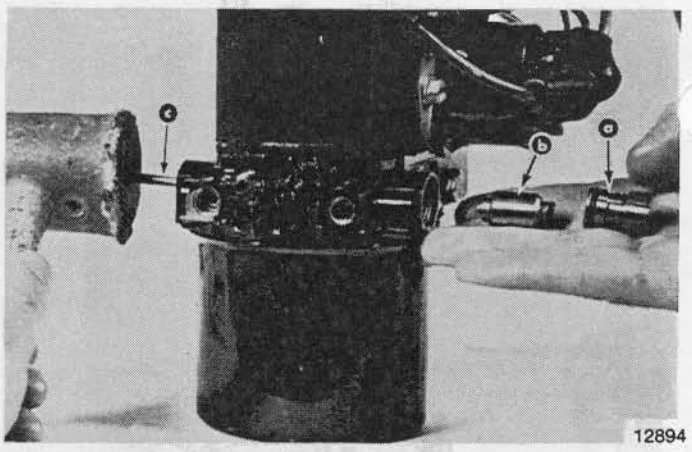
3. Remove and discard poppet valves.



12896

a - Poppet Valves (2) - Tip Pump to Remove; Discard Valves

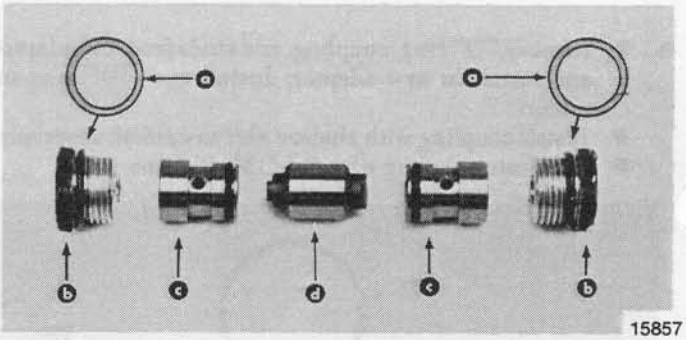
4. Remove check valve bodies and spool.



12894

a- Check Valve Body (2)
b - Spool
c - 1/8" In. Dia. Rod (This Rod Is Provided with Trim Pump Rebuild Kit)

5. ● Remove and discard "O" rings on hex plug retainers.
   ● Discard check valve bodies.
   ● Clean hex plug retainers and spool.



15857

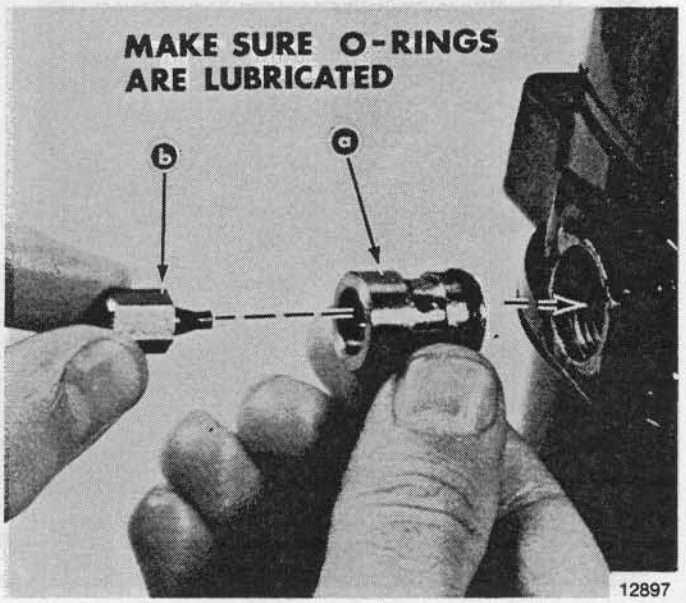
a - "O" Rings
b - Hex Plug Retainers
c - Check Valve Bodies
d - Spool

6. ● Lubricate check valve body "O" rings with Needle Bearing Assembly Lubricant 92-42649A1, or 10W-30 or 10W40 oil.

⚠CAUTION

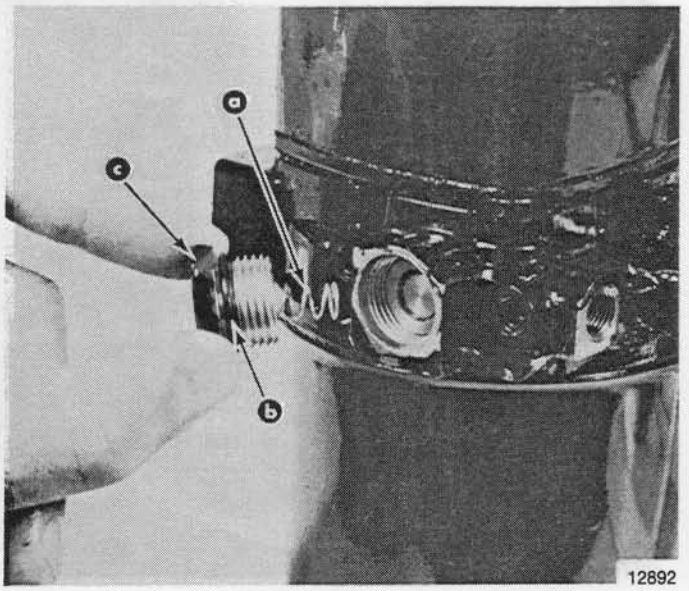
DO NOT force check valve body into adaptor as damage to "O" rings may result.

- Place - DO NOT FORCE - check valve bodies into adaptor; hex plugs will push valve bodies into adaptor.
- Place poppet valve into check valve body.



a - Check Valve body (2)
b - Poppet Valve (2)

7. ● Place springs in check valve bodies.
- Lubricate hex plug retainer "O" rings with Needle Bearing Assembly Lubricant 92-42649A1 or 10W30 or 10W-40 oil.
- Thread hex plug retainers into adaptor by hand until retainer contacts check valve body.

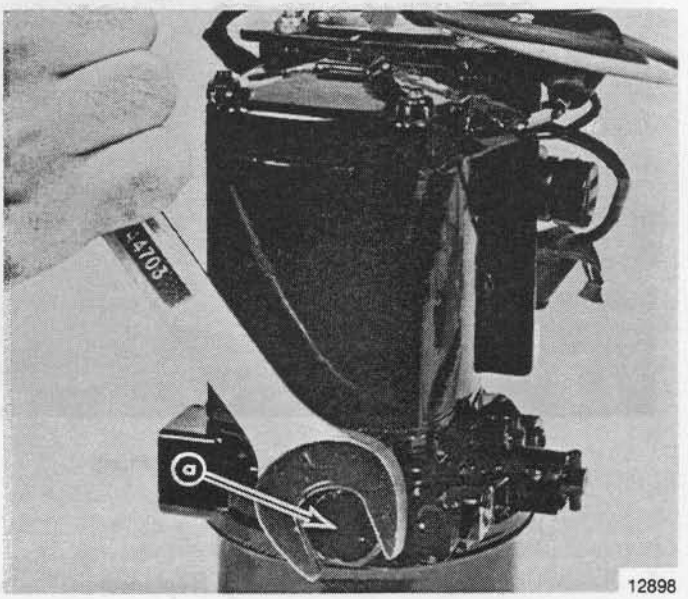


a - Spring (2)
b - "O" Ring (2)
c - Hex Plug Retainer

8. **⚠CAUTION**

Hex plug retainers MUST BE turned into adaptor exactly as outlined or damage to check valve body "O" rings may result.

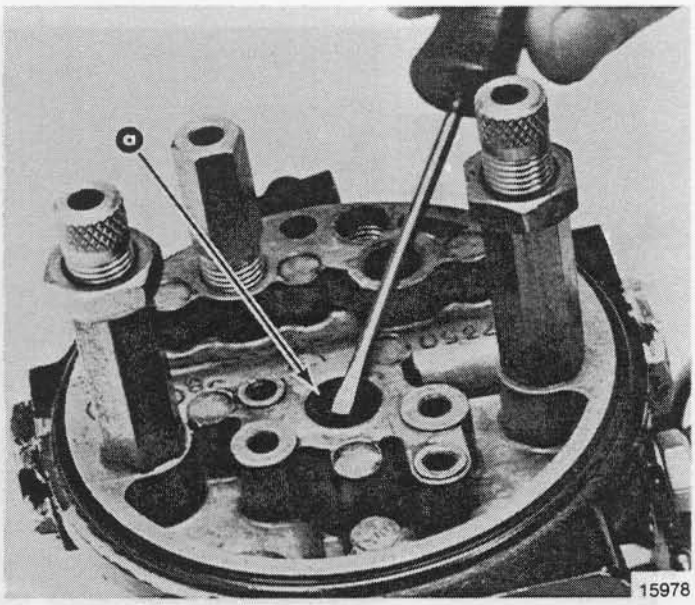
Tighten each hex plug retainer ¼-turn; then; back-off ⅛-turn - keep repeating until hex plug is tightened securely.



a - Hex Plug Retainer (2)

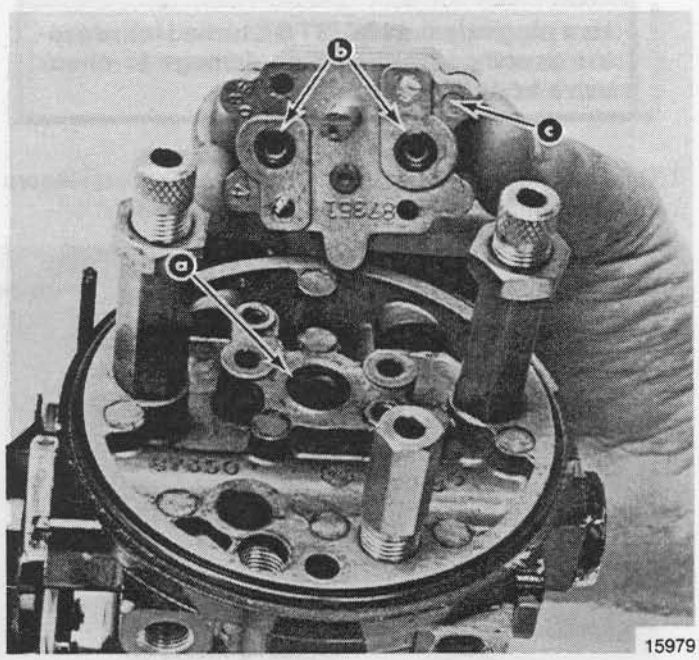
Pump Shaft Oil Seal Replacement

1. Remove oil reservoir.
2. Remove pump (Refer to "Pump Replacement" - see "Index").
3. Remove oil seal.



a - Oil Seal - Pry Out

4. ● Install new seal with lips toward pump. Oil seal can be pressed in by hand.
   ● If necessary, replace "O" rings on base of pump.



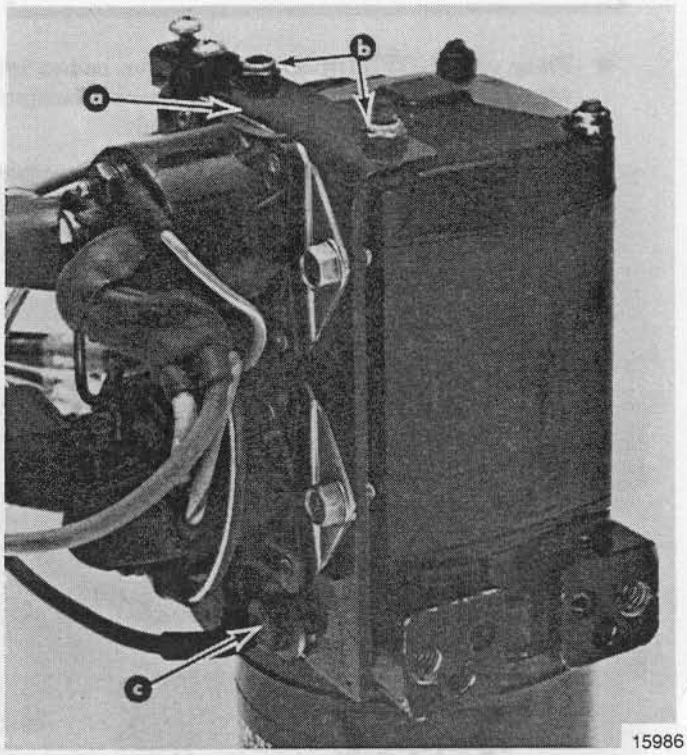
a - Oil Seal - Install with Lips Toward Pump
b - "O" Rings - Replace, If Necessary
c - Pump

5. Reinstall pump (Refer to "Pump Replacement" - see "Index").

MOTOR REPAIR

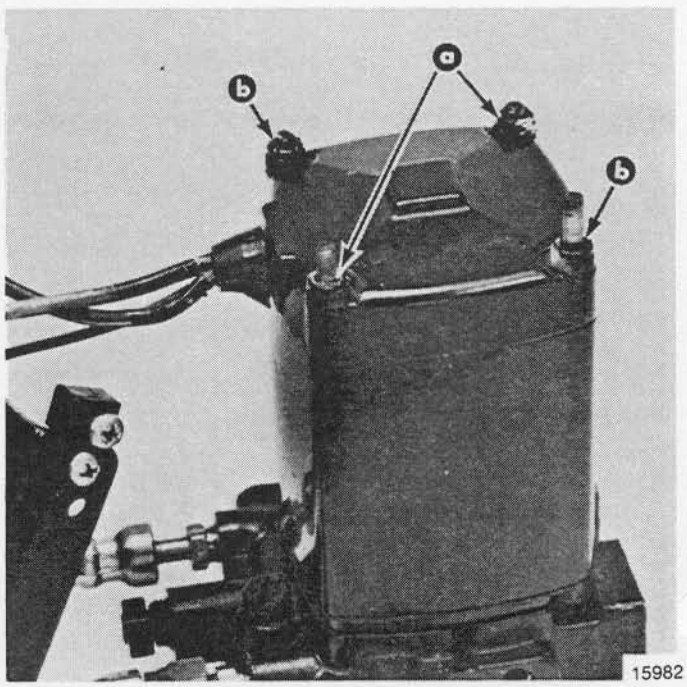
DISASSEMBLY

1. ● Remove solenoid plate.
   ● Disconnect motor leads (green-white, blue-white, and black) from solenoid terminals.



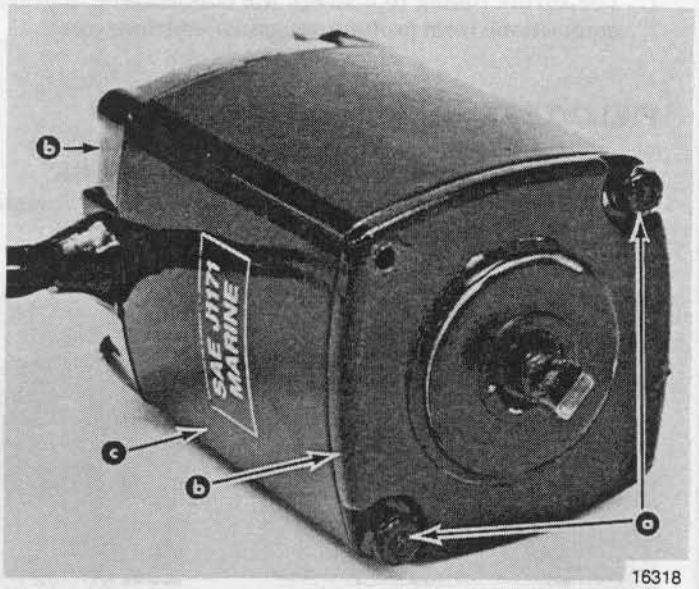
a - Solenoid Plate
b - Locknuts
c - Screw

2. Remove motor assembly; then, remove "O" ring from motor base.



a - Remove Locknuts (Studs May Turn Out)
b - DO NOT Loosen

3. Disassemble motor as follows:
   a. remove end frame caps
   b. remove thrust washer (if equipped)
   c. remove armature from field and frame assembly

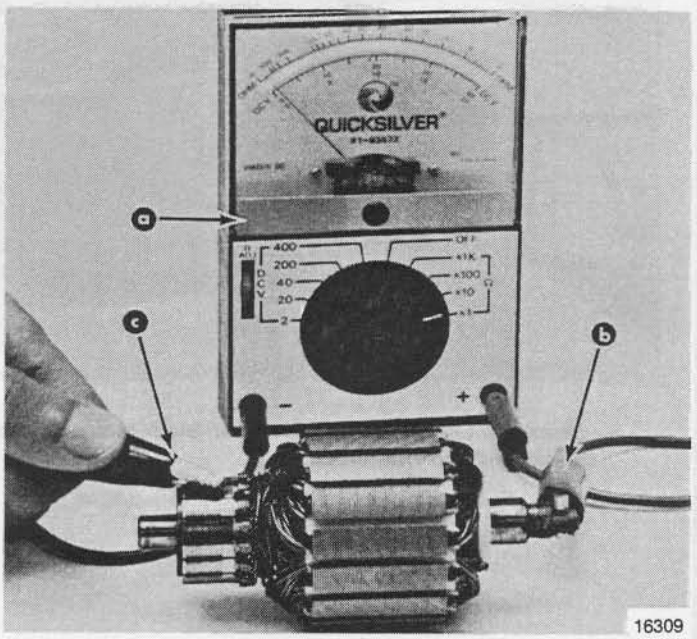


a - Locknuts
b - End Frame Caps
c - Field and Frame Assembly

ARMATURE TESTS

Test for Ground

1. Check armature for continuity.



a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place On Armature Shaft
c - Meter Lead - Place On All Commutator Bars (One at-a-Time)

2. **Continuity indicated** - Armature is grounded; replace armature.
   Continuity NOT indicated - Armature OK.

Test for Shorts

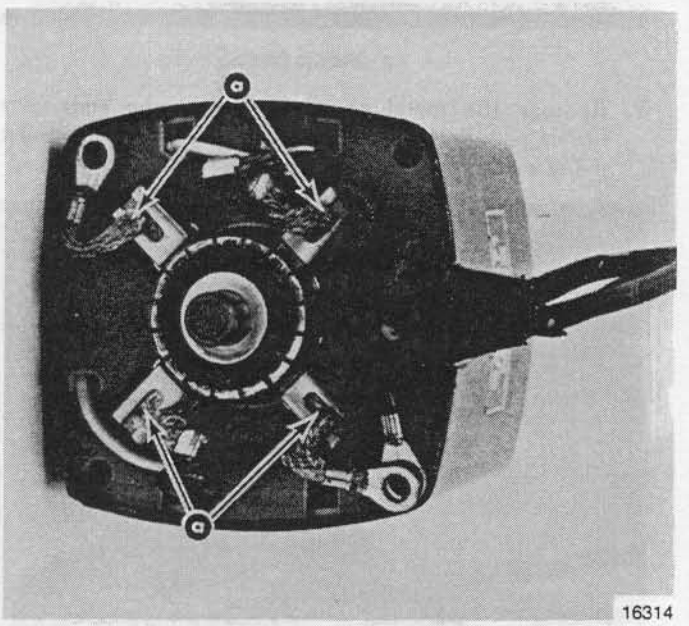
Check armature on a growler (follow growler manufacturer's test instructions). Indication of a short requires replacement.

Checking and Cleaning Commutator:

1. If commutator is worn it can be turned down on an armature conditioner tool or on a lathe.
2. Clean commutator with "OO" garnet grit sandpaper. DO NOT use emery paper.

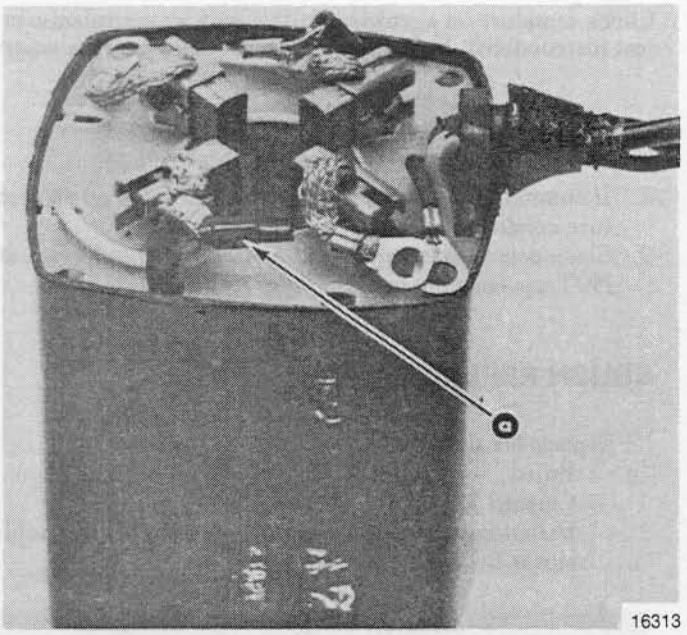
BRUSH REPLACEMENT

1. Replace brushes if:
   - Pitted
   - Chipped
   - Distance between brush pigtail and end of brush holder slot is 1/16 in. (1.6 mm) or less.



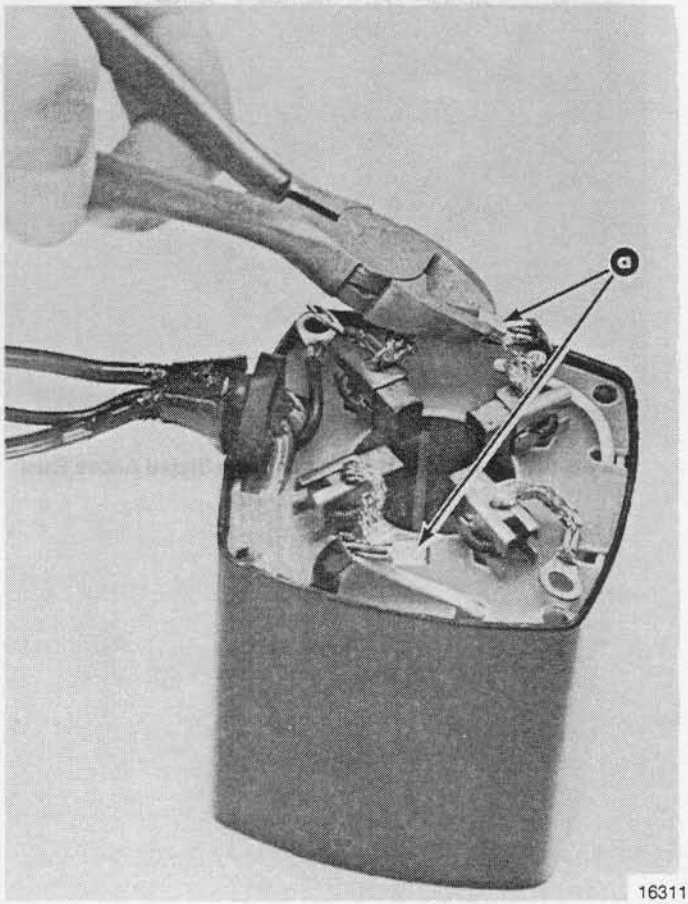
a - Brushes - Replace If Any Conditions Stated Above Exist

2. Remove plastic casing.



a - Plastic Casing

3. Remove the metal connectors from the ends of the brush pigtails by separating the slit in the connectors using a side cutter. Retain connectors.

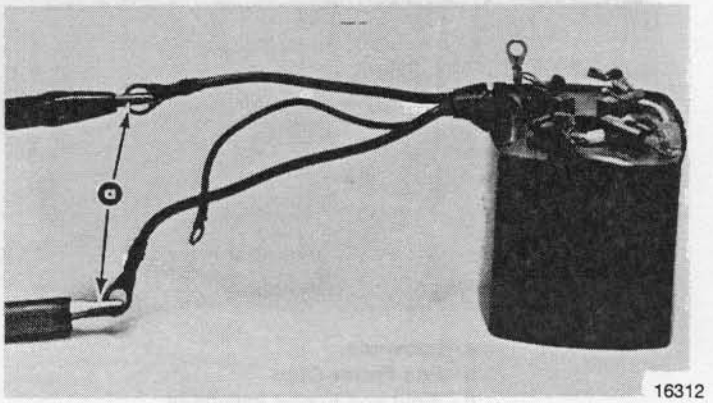


a - Metal Connectors

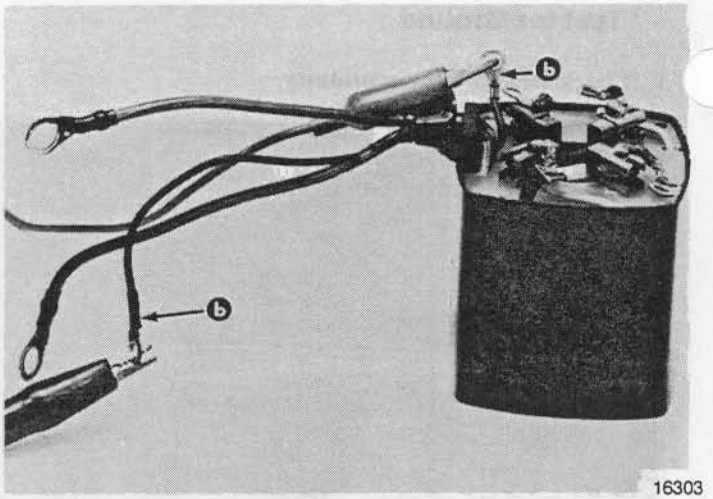
4. Remove old brush card from field and frame assembly.
5. Insert new brush card into field and frame assembly.
6. Connect brush pigtails to field leads with metal connectors. Crimp metal connectors with a pliers.
7. Use shrink tubing to insulate the connections to prevent connections from grounding against end frame cap.

FIELD TESTS

1. • **Zero ohms read (full continuity)** - field OK.
   • **Zero ohms NOT read (no continuity)** - replace field and frame assembly.



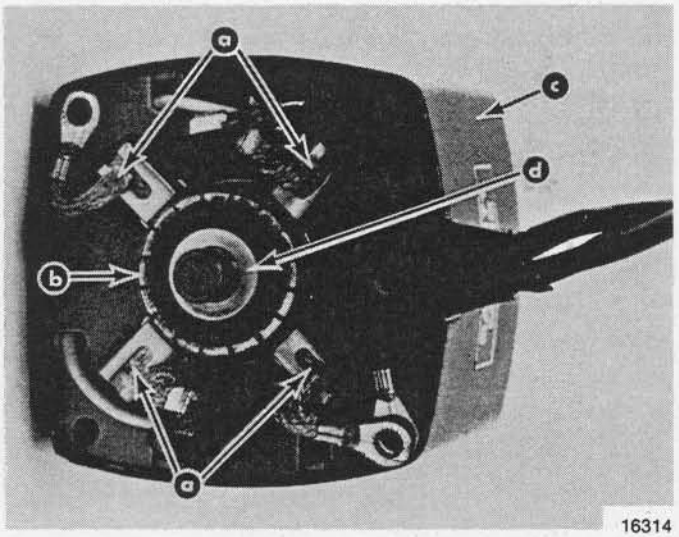
a - Ohmmeter Leads - Connect Between Green-White and Blue-White Motor Leads.



b - Ohmmeter Leads - Connect Between Black Motor Lead and Black Field and Frame Lead.

REASSEMBLY

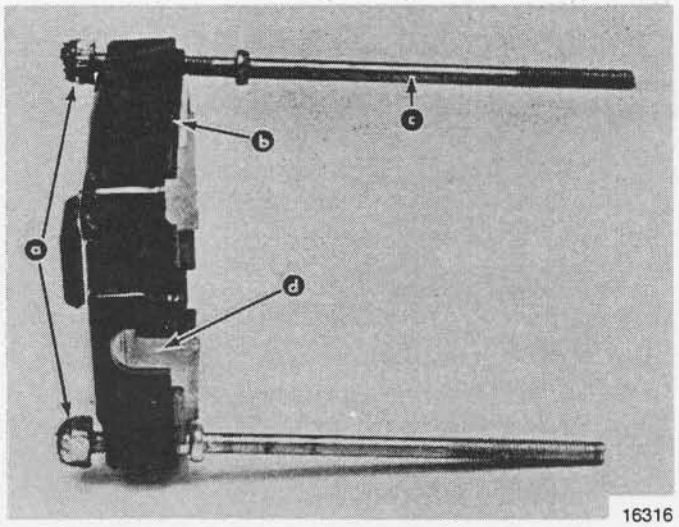
1. ● Spread brushes and install armature into field and frame assembly.
   ● Install thrust washer, if equipped, onto armature shaft.



16314

a - Brushes
b - Armature
c - Field and Frame Assembly
d - Thrust Washer (If Equipped)

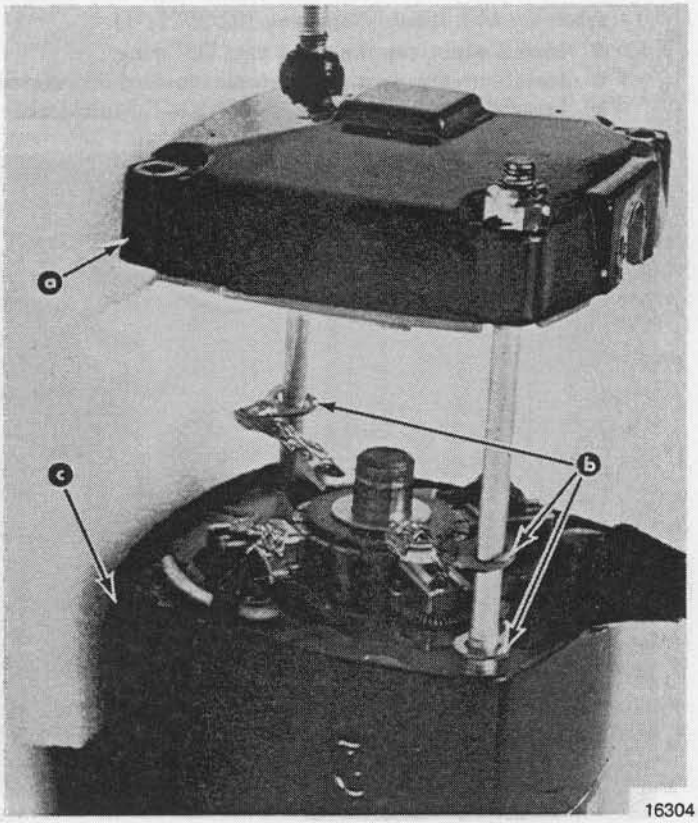
2. ● Install thru studs.
   ● Hold studs in soft jawed vise and tighten locknuts against cap.



16316

a - Locknuts
b - Upper End Cap
c - Longer Stud
d - End Cap Motor Lead Recess

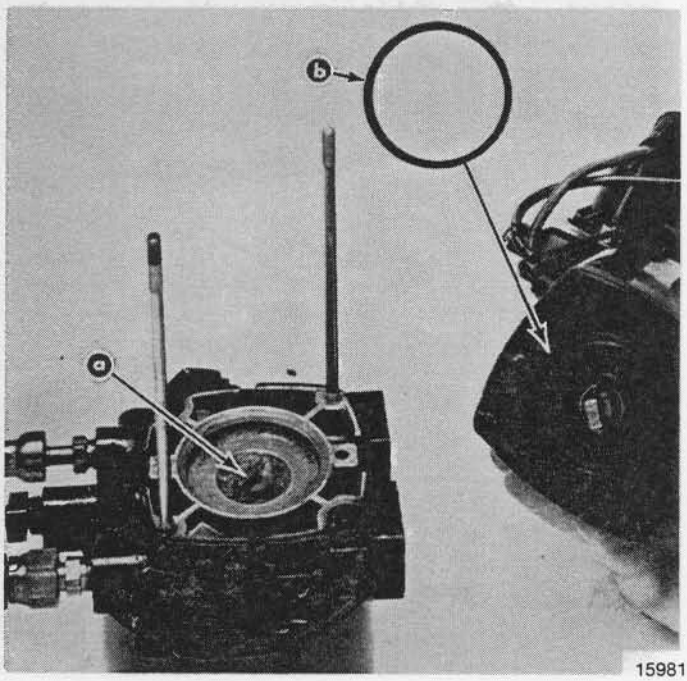
3. Install upper end frame cap - insert studs thru brush lead ring terminals and stud holes.



16304

a - Upper End Cap
b - Brush Lead Ring Terminals
c - Field and Frame Assembly

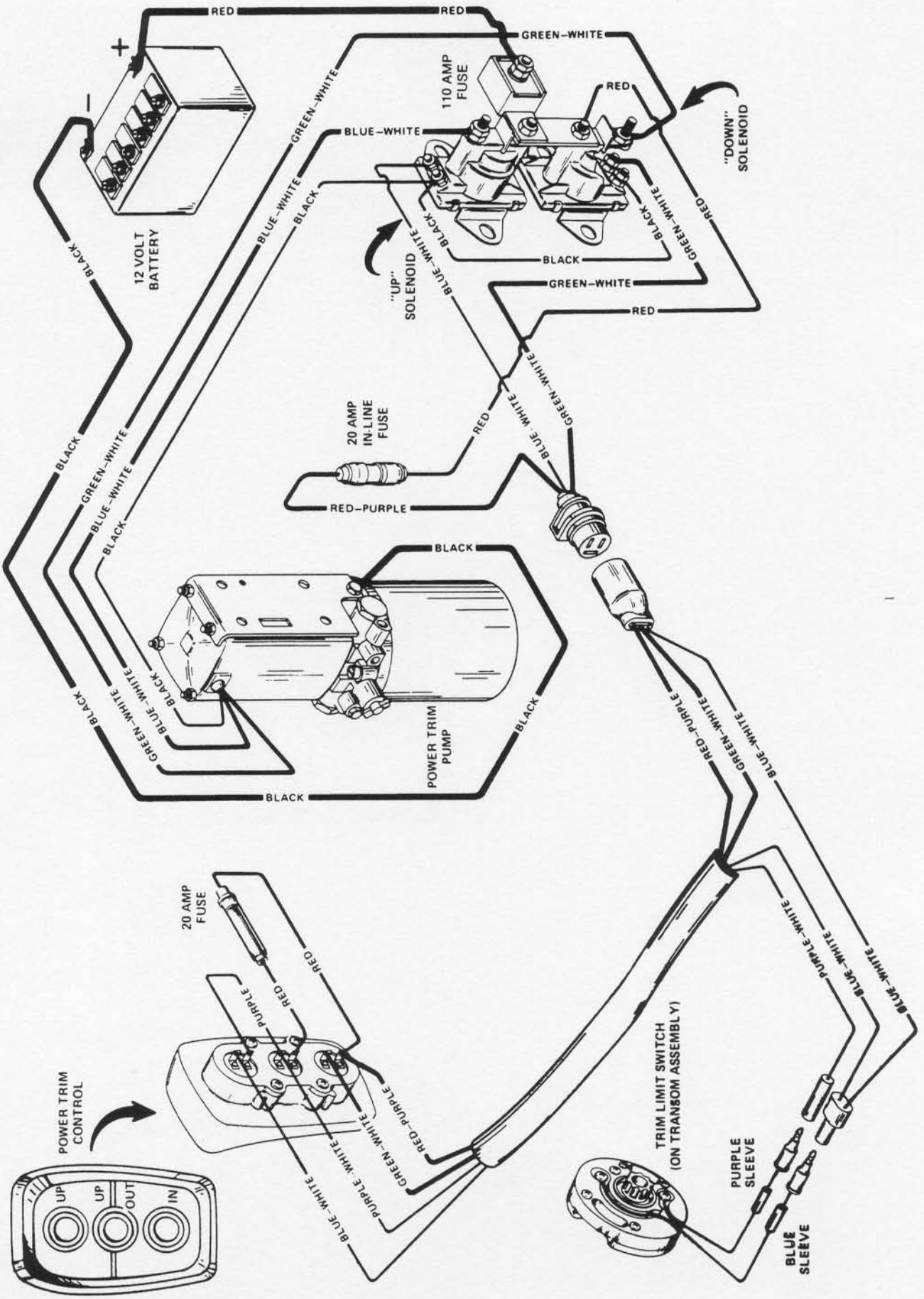
4. Install lower end frame cap onto thru studs.
5. Install locknuts and tighten securely.
6. Seal the seams between end frame caps and field and assembly with Liquid Neoprene (92-25711-1).
7. ● Install studs, coupling and new "O" ring.
   ● Install coupling with shallow slot toward oil resevoir.
   ● Liberally lubricate coupling with 2-4-C Multi-Lube.



15981

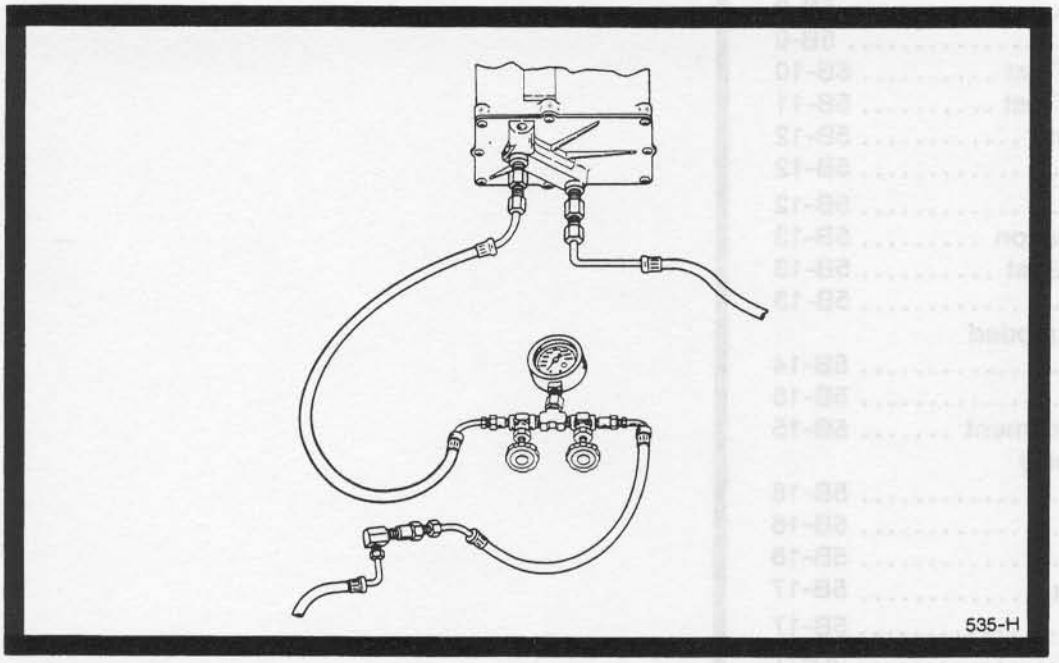
a - Coupling (Shallow Slot Toward Oil Reservoir)
b - "O" Ring

8. Install motor assembly.



OILDYNE POWER TRIM SYSTEM WIRING DIAGRAM

POWER TRIM



PRESTOLITE LOW PRESSURE POWER TRIM

5 B

mercruiser
STERN DRIVES & INBOARDS

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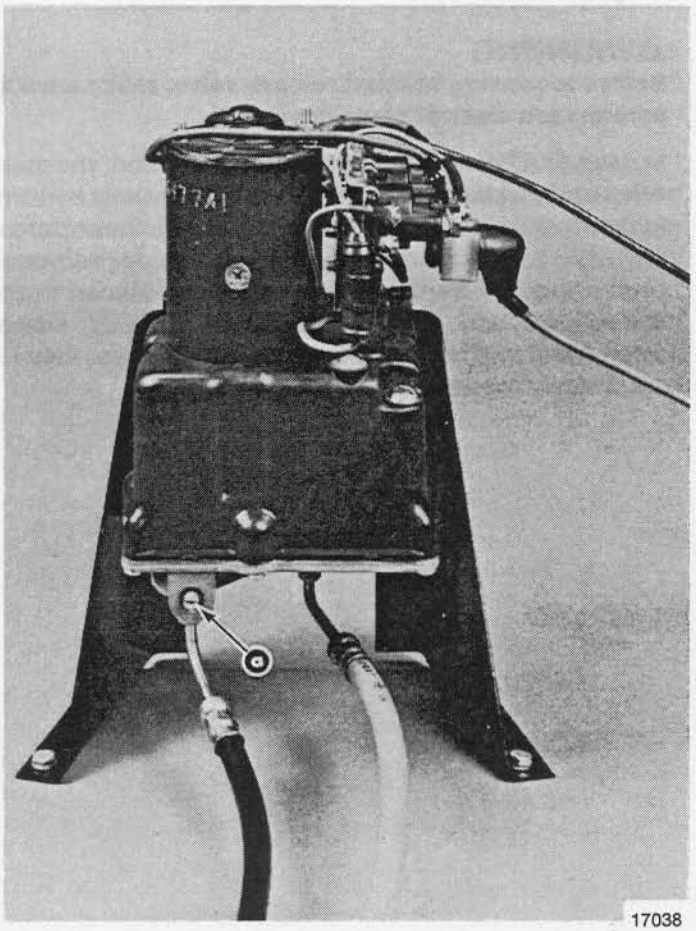
Identification

Some MerCruiser TR/TRS Stern Drives will be equipped with a low pressure, high volume Prestolite Power Trim pump. This pump was used interchangeably with the Oildyne pump for a period of time and differs from the early style high pressure, low volume Prestolite pump covered in section 5-C.

The Prestolite low pressure, high volume pump can be identified by the "Manual Release Valve" located on the pump's valve body and gear assembly (Figure 1). Identification also can be made by the exclusion of the external reverse lock valve (used in the early system). The reverse lock feature is integrated into the Power Trim System.



a - Manual Release Valve

Figure 1. Prestolite Power Trim Pump

Specifications

VALVE PRESSURE SPECIFICATIONS

Valve	
Up Circuit	2200-2600 P.S.I. (15173-17932)
Down Circuit	400-600 P.S.I. (2759-4138 kPa)

ELECTRICAL SPECIFICATIONS

Pump Amperage Draw	115 Amps at 2200-2600 P.S.I. (15173-17932 kPa)

SPECIAL TOOLS

Test Gauge Kit	91-52915A3
Multi-Meter (Ohmmeter)	91-93572

QUICKSILVER LUBRICANTS, ADHESIVES, AND SEALERS

2-4-C Marine-Lubricant	92-90018A12
Liquid Neoprene	92-25711-1

Description

The Prestolite Power Trim Pump has internal valving that eliminates the need for an external reverse lock, as was required in the past. The pump generates a higher volume of fluid, but at a lower pressure than previous Prestolite pumps. This, in conjuction with larger I.D. hydraulic hoses (gimbal housing to pump) and larger I.D. trim cylinders, should allow the drive unit to "kick-up" easier if an underwater object is struck.

⚠CAUTION

Due to differences in internal valving, the low pressure, high volume Prestolite trim pump cannot be used to replace an earlier high pressure, low volume Prestolite pump, or vice-versa. Use of incorrect pump will affect trim operation and may cause damage to trim system.

The pump motor is protected from overheating by an internal circuit breaker (on commutator end plate), that interrupts the current flow thru the field windings in the events of an overheating condition. Electrical current overload protection is provided to the pump by a 110 amp fuse. Pump also is fitted with a 20 amp in-line fuse, which serves to protect the trim control and harness from an overload.

Thermal Circuit Breaker Operation

If the "In"/"Down" or "Trailer" trim switch is kept depressed after drive unit reaches its end of travel, a thermal circuit breaker will open to prevent pump motor from overheating and pump motor will stop. Release switch(es) as soon as drive unit reaches end of travel, to prevent this from happening. If circuit breaker should open, allow motor to cool down and circuit breaker will automatically reset.

Manual Release Valve Operation

⚠WARNING

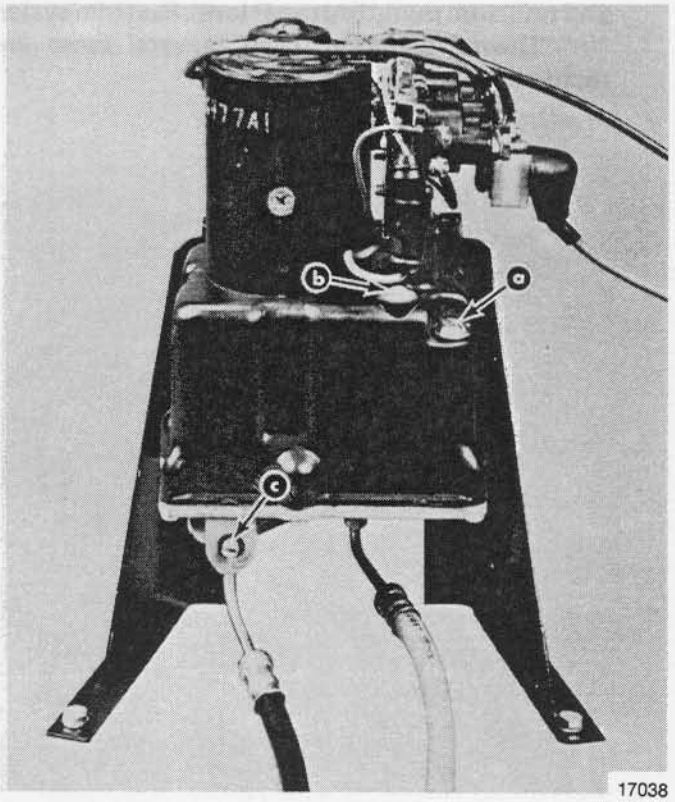
Before loosening manual release valve, make sure all persons are clear of stern drive unit.

In case of a Power Trim system malfunction, the stern drive unit can be raised and lowered manually by turning the manual release valve counterclockwise approximately 3 turns and moving drive unit to desired position by hand. After drive unit has been placed in the desired position, close valve COMPLETELY. Power Trim system will not function properly, unless valve is completely closed.

Maintaining Power Trim Pump Oil Level

1. Place drive unit in the full "In"/"Down position.
2. • Remove "Fill" screw from pump.
   • Oil level should be up to bottom of the threads in "Fill" screw hole. If necessary, add SAE 10W30 or 10W40 motor oil (thru "Fill" screw hole).

NOTE: In tropical areas, single viscosity SAE30 motor oil can be used.



17038

a - Fill Screw
b - Vent Screw
c - Manual Release Valve

3. Raise and lower drive unit 6 to 10 times to purge any air from system; then, recheck oil level (with drive unit fully "In"/"Down") and add oil if necessary.

⚠CAUTION

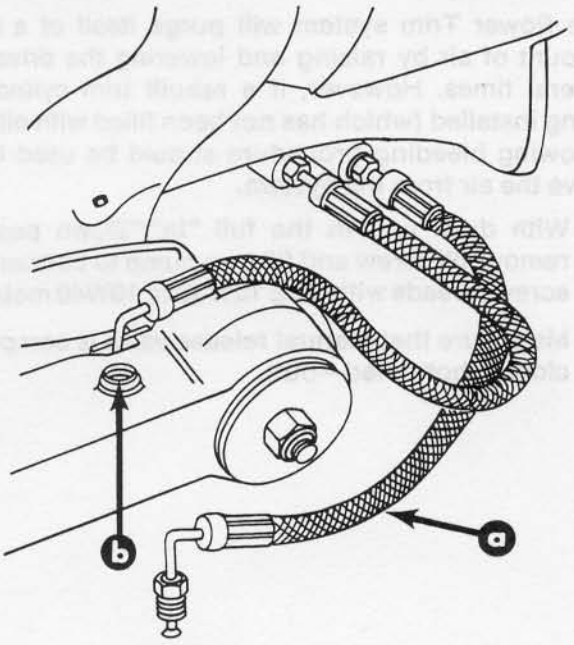
"Vent" screw must be backed out 2 full turns to vent pump reservoir. FAILURE TO VENT RESERVOIR COULD AFFECT PUMP OPERATION and/or CAUSE DAMAGE TO SEALS AND "O" RINGS.

Air Bleeding Power Trim System

The Power Trim system will purge itself of a small amount of air by raising and lowering the drive unit several times. However, if a rebuilt trim cylinder is being installed (which has not been filled with oil), the following bleeding procedure should be used to remove the air from the system.

1. With drive unit in the full "In"/"Down position, remove fill screw and fill trim pump to bottom of fill screw threads with SAE 10W30 or 10W40 motor oil.
2. Make sure that manual release valve is completely closed (bottomed—out).

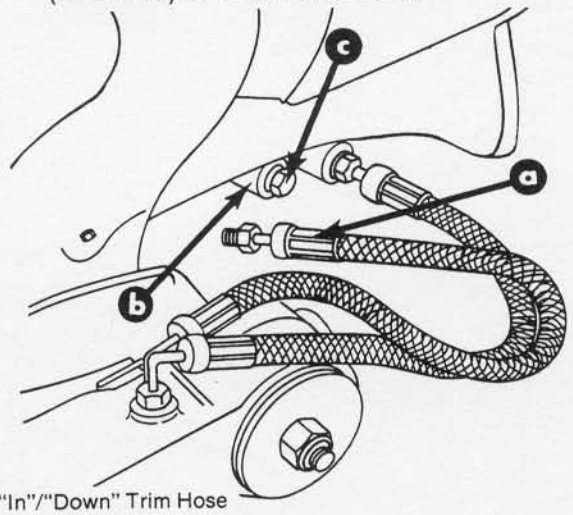
3. Disconnect "Out"/"Up" hose from front connection on rebuilt trim cylinder. If both cylinders were rebuilt, disconnect hose from both cylinders.



a - "Out"/"Up" Trim Hose
b - Front Connection On Trim Cylinder

Bleeding "Out"/"Up" Trim Circuit

4. Direct end of trim hose(s) into a container; then, run trim pump in the "Out"/"Up" direction until a solid, air-free stream of oil is expelled from hose(s). Reconnect hose(s) and tighten securely.
5. Refill trim pump to proper level.
6. • Disconnect "In"/"Down" trim hose from rear connection on gimbal housing hydraulic connector. If both cylinders were rebuilt, disconnect hose from aft connection on both sides of connector.
   • Plug port(s) in hydraulic connector, using plug (22-38609) or a suitable device.



a - "In"/"Down" Trim Hose
b - Hydraulic Connector
c - Plug (22-38609)

Bleeding "In"/"Down" Trim Circuit

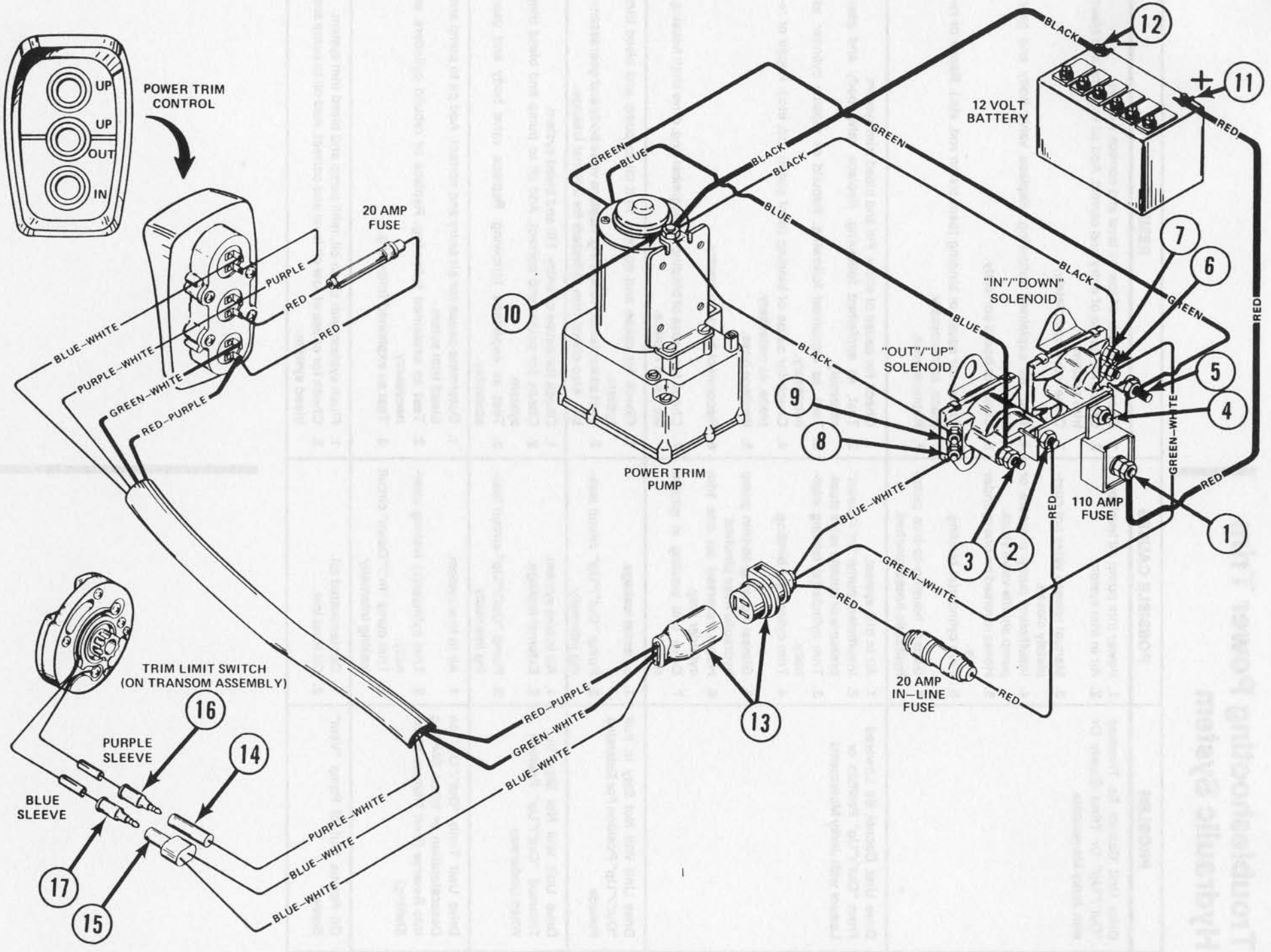
7. Direct end of trim hose(s) into a container. Run trim pump in the "Out"/"Up" direction until trim cylinders are fully extended. If both cylinders are being bled, pump must be refilled with oil when cylinders are extened about half-way, to prevent pump from running out of oil.
8. Remove plug(s) from gimbal housing hydraulic connector and momentarily run trim pump in the "In"/"Down' direction until a solid, air-free stream of oil is expelled from connector. Reconnect trim hose(s) and tighten securely.
9. Lower drive unit to the full "In"/"Down" position and refill trim pump to proper level. Run trim system "In"/"Down" and "Out"/"Up" several times and recheck oil level.

Troubleshooting Power Trim Electrical System

NOTE: Refer to wiring diagram, following, for assistance in electrical system troubleshooting.

PROBLEM	POSSIBLE CAUSES	REMEDY
Power Trim Pump Motor Will Not Run in The "Out"/"Up" or "In"/"Down" Direction -- **Solenoids Do Not Click** *Does not apply to an intermitt problem.	1. Thermal circuit breaker in pump motor open 2. *20 amp fuse blown. 3. Power trim pump battery cables or wiring harness connections corroded or loose. 4. Trim control wiring harness connector loose or corroded. 5. *110 amp fuse blown. 6. Open circuit in trim control wiring harness.	1. Replace commutator end plate assy. 2. Determine cause for blown fuse and correct before replacing fuse. *NOTE: If fuse blows while trimming "Out"/"Up" or raising drive unit, problem may be due to grounded trim limit switch leads.* To check for grounded condition, disconnect trim limit switch leads at bullet connector "14", "15", "16", and "17" (in wiring diagram). If drive unit can now be raised (using "Trailer" switch), trim limit switch or leads are grounded. 3. Clean and/or tighten connections "1", "2", "4", "10", "11" and "12", as necessary. 4. Clean and secure connection "13", as necessary. 5. Check for voltage at terminal "4". If no voltage is indicated, determine cause for blown fuse and correct, then replace fuse. (Trimming "Out"/"Up" and "In"/"Down" simultaneously will blow fuse.) 6. Check for battery voltage at terminal "8" while trimming "Out"/"Up" and at terminal "6" while trimming "In"/"Down". If no voltage is indicated, check trim control for a loose or corroded connection or a damaged power supply lead in harness.
Power Trim Pump Will Not Run In The "Out"/"Up" or "In"/"Down" Direction -- **Both Solenoids Click**	1. Faulty solenoids or loose or corroded connections. 2. Pump motor brushes stuck, corroded or worn out. 3. Armature commutator dirty. 4. Armature faulty. 5. Field and frame faulty. 6. Pump gears froze. 7. Power trim pump harness or trim control harness shorted between "Out"/"Up" and "In"/"Down" circuit (pump trying to run in "Out"/"Up" and "In"/"Down" direction simultaneously).	1. Check for battery voltage at terminal "5" (in wiring diagram) while trimming "In"/"Down" and at terminal "3" while trimming "Out"/"Up". If no voltage is indicated, check connections "2", "3", "4" and "5" and/or replace solenoids. 2. Clean or replace, as required. 3. Clean or replace armature, as required. 4. Test for shorted, open or grounded condition and replace if bad. 5. Check for open or grounded condition. Replace field and frame assembly, if bad. 6. Replace pump valve body and gear assembly. 7. Disconnect blue-white lead from solenoid terminal "8". If pump motor will now run in the "In"/"Down" direction, a short in harness exists. Repair or replace harness, as necessary.
Power Trim Pump Motor Runs In The "Out"/"Up" Direction, But Not In The "In"/"Down" Direction -- **"In"/"Down" Solenoid Does Not Click**	1. Loose or dirty solenoid connections. 2. Open "In"/"Down" circuit in trim control or pump wiring harness. 3. Solenoid faulty.	1. Check connections "6" and "7" (in wiring diagram) and clean and/or tighten, as required. 2. Check for battery voltage at terminal "6" while trimming "In"/"Down". If no voltage is indicated, check for a loose or corroded "In"/"Down" circuit connection, damaged "In"/"Down" circuit lead or a faulty "In"/"Down" trim switch. Repair or replace, as required. 3. Replace solenoid.

PROBLEM	POSSIBLE CAUSES	REMEDY
Power Trim Pump Motor Runs In The "Out"/"Up" Direction But Not In The "In"/"Down" Direction -- **"In"/"Down" Solenoid Clicks**	1. Loose or dirty solenoid connection. 2. Faulty solenoid. 3. Faulty "In"/"Down" field winding.	1. Check connections "4" and "5" (in wiring diagram). Clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "5" while trimming "In"/"Down". If no voltage is indicated, replace solenoid. 3. Replace field and frame assembly.
Power Trim Pump Motor Runs In "In"/"Down" Direction But Not "Out"/"Up" Direction (Both Trim and Trailer Switches Inoperative) - **"Out"/"Up" Solenoid Does Not Click**	1. Loose or dirty solenoid connections. 2. Open "Out"/"Up" circuit in trim control or pump wiring harness. 3. Solenoid faulty.	1. Check connections "8" and "9" (in wiring diagram). Clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "8" while trimming "Out"/"Up". If no voltage is indicated, check for a loose or corroded "Out"/"Up" circuit connection, blown fuse (if trim control is so equipped), damaged "Out"/"Up" circuit lead, or a faulty "Out"/"Up" trim switch. Repair or replace, as necessary. 3. Replace solenoid.
Power Trim Pump Motor Runs In "In"/"Down" Direction, But Not "Out"/"Up" Direction (Both Trim and Trailer Switches Inoperative) - **"Out"/"Up" Solenoid Clicks**	1. Loose or dirty solenoid connection. 2. Faulty solenoid. 3. Faulty "Out"/"Up" field winding.	1. Check connections "2" and "3" (in wiring diagram) and clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "3" while trimming "Out"/"Up". If no voltage is indicated, replace solenoid. 3. Replace field and frame assembly.
Trim Control "Out"/"Up" Trim Switch Inoperative - **Trailer Switch Operates**	1. Trim limit switch lead bullet connectors loose or corroded. 2. Trim limit switch or leads faulty. 3. Open in trim control "Out"/"Up" circuit.	1. Clean and/or tighten connections "14", "15", "16" and "17" (in wiring diagram), as necessary. 2. Disconnect trim limit switch leads from trim harness. Connect a continuity meter between leads "16" and "17". Continuity should be indicated with drive unit in full "In"/"Down" position. If not, check for damaged leads or poor connections. If this is not the cause, replace limit switch. 3. Check for a loose or corroded "Out"/"Up" circuit connection, damaged "Out"/"Up" circuit lead or faulty "Out"/"Up" trim switch. Repair or replace, as necessary.
Trim Control Trailer Switch Inoperative -- **Trim "Out"/"Up" Switch Functions**	1. Open in trim control trailer circuit.	1. Check for a faulty trailer switch, loose or corroded connections or damaged trailer circuit lead.
Trim System Functions While Unattended	1. Faulty trim or trailer switch. 2. Shorted trim pump harness or trim control harness.	1. Replace switch. 2. Repair or replace, as required.


UP
UP
OUT
IN
POWER TRIM CONTROL
20 AMP FUSE
BLUE–WHITE
PURPLE–WHITE
GREEN–WHITE
RED–PURPLE
PURPLE
RED
RED
12 VOLT BATTERY
BLACK
GREEN
BLUE
BLACK
BLACK
BLUE
GREEN
BLACK
BLUE
RED
"IN"/"DOWN" SOLENOID
"OUT"/"UP" SOLENOID
POWER TRIM PUMP
110 AMP FUSE
GREEN–WHITE
RED
BLUE–WHITE
RED
GREEN–WHITE
RED
20 AMP IN–LINE FUSE
RED
TRIM LIMIT SWITCH (ON TRANSOM ASSEMBLY)
PURPLE SLEEVE
BLUE SLEEVE
RED–PURPLE
GREEN–WHITE
BLUE–WHITE
PURPLE–WHITE
BLUE–WHITE
BLUE–WHITE
1
2
3
4
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6
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10
11
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14
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17

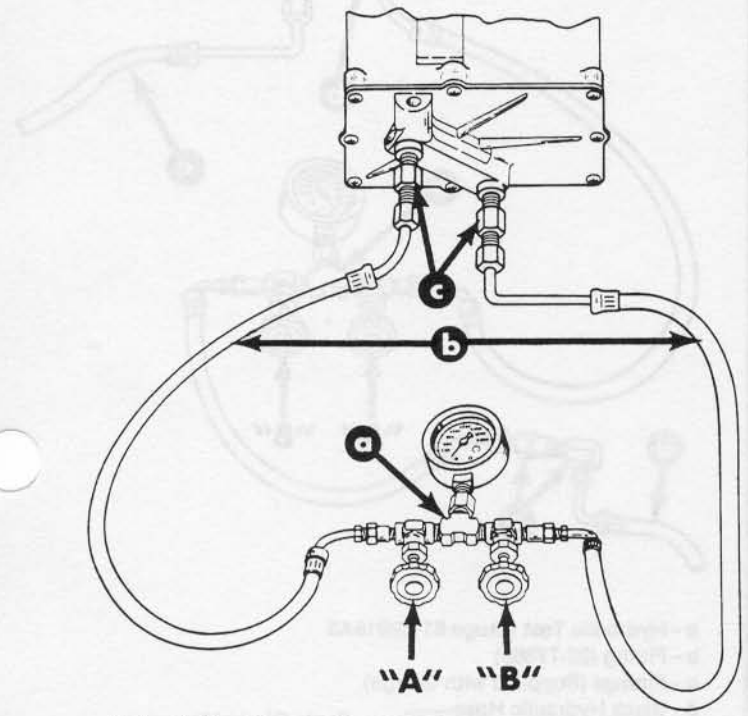
Troubleshooting Power Trim Hydraulic System

PROBLEM	POSSIBLE CAUSES	REMEDY
Drive Unit Cannot Be Trimmed "Out"/"Up" Or Trims Slowly Or with Jerky Movements	1. Power trim pump oil level low. 2. Air in trim system. 3. Manual release valve not completely closed. 4. Insufficient pump pressure or pump shuttle valve stuck. 5. Hoses reversed on one cylinder only. 6. Trim cylinder(s) binding. 7. Gimbal housing-to-trim pump hydraulic hoses pinched.	1. Check for cause of low oil level and correct. Add oil. 2. Check for cause of entry and correct. Add oil to pump and bleed trim system. 3. Close valve completely. 4. Test, as explained following. Replace valve body and gear assembly. 5. Connect hoses correctly. 6. Check for cause of binding (bent piston rod, etc.). Repair or replace, as necessary. 7. Replace hose.
Drive Unit Cannot Be Lowered From "Out"/"Up" Position or Lowers with Jerky Movements	1. Air in trim system. 2. Insufficient pump "In"/"Down" pressure or shuttle valve stuck. 3. Trim cylinder(s) leaking internally. 4. Trim cylinder(s) binding. 5. Gimbal housing-to-trim pump hydraulic hose pinched. 6. Hoses reversed on one trim cylinder only. 7. Drive unit binding in gimbal ring.	1. Check for cause of entry. Fill and bleed trim system. 2. Test, as explained following. Replace valve body and gear assembly. 3. Test, as explained following. Rebuild or replace cylinder, as necessary. 4. Check for cause of binding (bent piston rod, etc.). Repair or replace, as necessary. 5. Replace hose. 6. Reconnect hoses correctly. 7. Check for cause of binding (bent gimbal ring, drive shaft housing, etc.) and replace.
Drive Unit Will Not Stay In Full "Out"/"Up" Position For Extended Periods	1. External leakage. 2. Pump "Out"/"Up" circuit leaking internally.	1. Check for cause and correct. Add oil to pump and bleed trim system. 2. Test as explained following. Replace valve body and gear assembly. Also check trim cylinders for internal leakage.
Drive Unit Will Not Stay In Trimmed "Out"/"Up" Position When Underway	1. Air in trim system. 2. External leakage. 3. Pump "Out"/"Up" circuit leaking internally.	1. Check for cause of entry. Fill and bleed system. 2. Check for cause and correct. Add oil to pump and bleed trim system. 3. Test as explained following. Replace valve body and gear assembly.
Drive Unit Trails "Out"/"Up" on Deacceleration or When Shifting Into Reverse (Unit Thumps When Shifting)	1. Air in trim system. 2. Trim cylinder(s) leaking internally. 3. Trim pump "In"/"Down" circuit leaking internally.	1. Determine cause for air entry and correct. Add oil to pump and bleed trim sytem. 2. Test as explained following. Replace or rebuild cylinders, as necessary. 3. Test as explained following.
Oil Foams Out of Pump "Vent" Screw	1. Contaminated oil. 2. Oil level low.	1. Flush system with clean oil, refill pump and bleed trim system. 2. Check for cause of low oil level and correct. Add oil to pump and bleed system.

Testing Power Trim System

Power Trim Pump Test

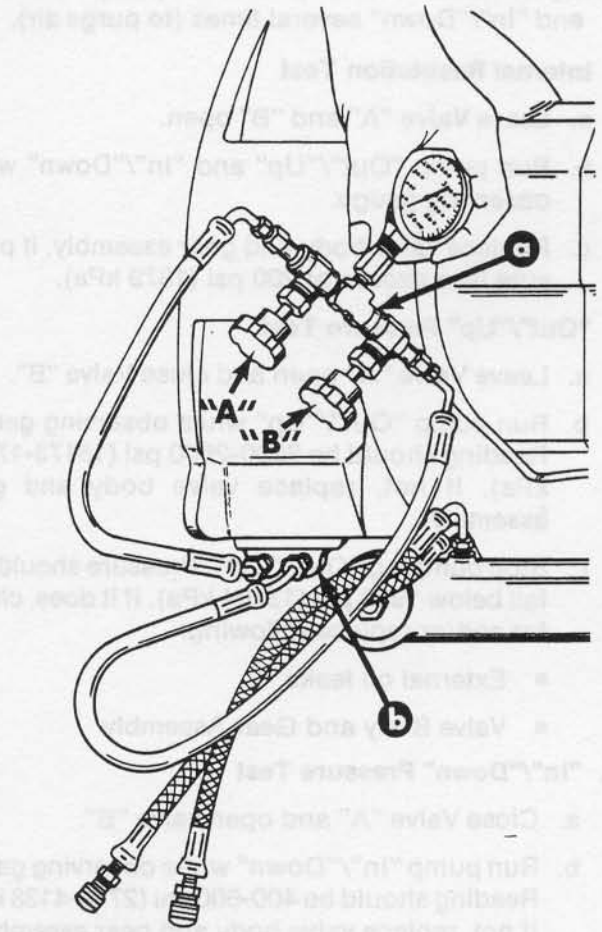
1. Before proceeding -
   - Check that "Manual Release Valve" is completely closed.
   - Check trim pump oil level.
   - Check for external leaks.
   - Place drive unit in full "In"/"Down" position.
2. Connect test gauge at most convenient location.

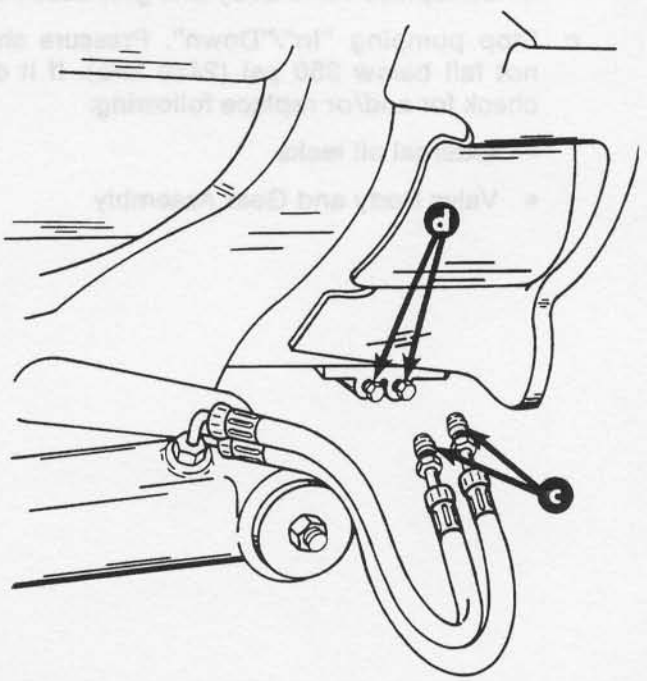


a - Hydraulic Test Gauge 91-52915A3
b - Extension Hoses 32-87221A1
c - Fittings 22-77366

NOTE: Extension hoses MUST BE used to obtain accurate readings.

Gauge Connected at Pump





a - Test Gauge 91-52915A3
b - Gimbal Housing Hydraulic Connector
c - Caps — Supplied with Gauge
d - Plugs — Supplied with Gauge

Gauge Connected at Housing Hydraulic Connector

3. Open Valve "A" and "B" and run pump "Out"/"Up" and "In"/"Down" several times (to purge air).

4. **Internal Restriction Test**

   a. Leave Valve "A" and "B" open.

   b. Run pump "Out"/"Up" and "In"/"Down" while observing gauge.

   c. Replace valve body and gear assembly, if pressure is in excess of 200 psi (1379 kPa).

5. **"Out"/"Up" Pressure Test**

   a. Leave Valve "A" open and close Valve "B".

   b. Run pump "Out"/"Up" while observing gauge. Reading should be 2200-2600 psi (15173-17932 kPa). If not, replace valve body and gear assembly.

   c. Stop pumping "Out"/"Up". Pressure should not fall below 1900 psi (13104 kPa). If it does, check for and/or replace following:

      - External oil leaks
      - Valve Body and Gear Assembly

6. **"In"/"Down" Pressure Test**

   a. Close Valve "A" and open valve "B".

   b. Run pump "In"/"Down" while observing gauge. Reading should be 400-600 psi (2759-4138 kPa). If not, replace valve body and gear assembly.

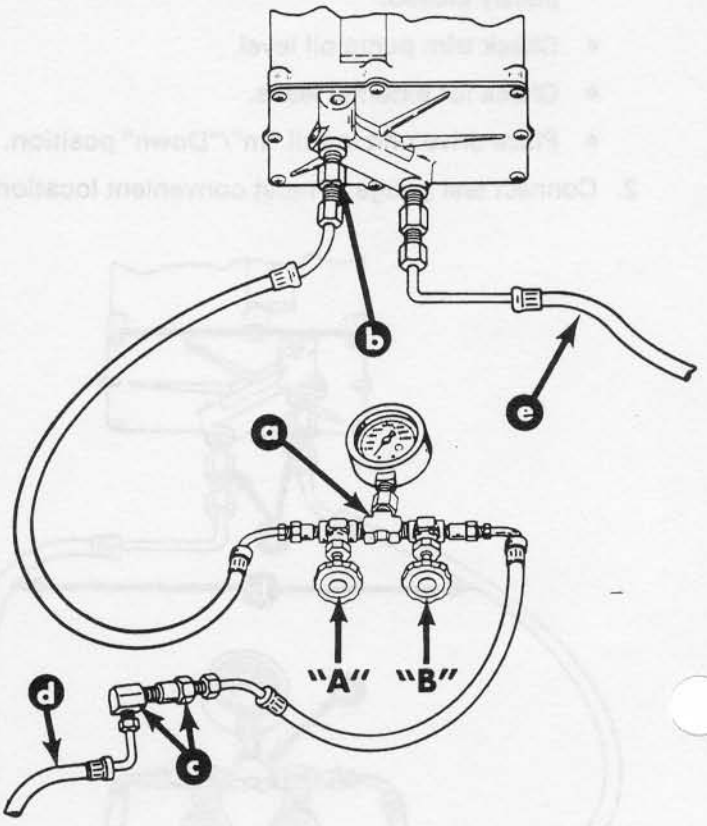
   c. Stop pumping "In"/"Down". Pressure should not fall below 350 psi (2410 kPa). If it does, check for and/or replace following:

      - External oil leaks
      - Valve Body and Gear Assembly

Trim Cylinder Internal Leak Test

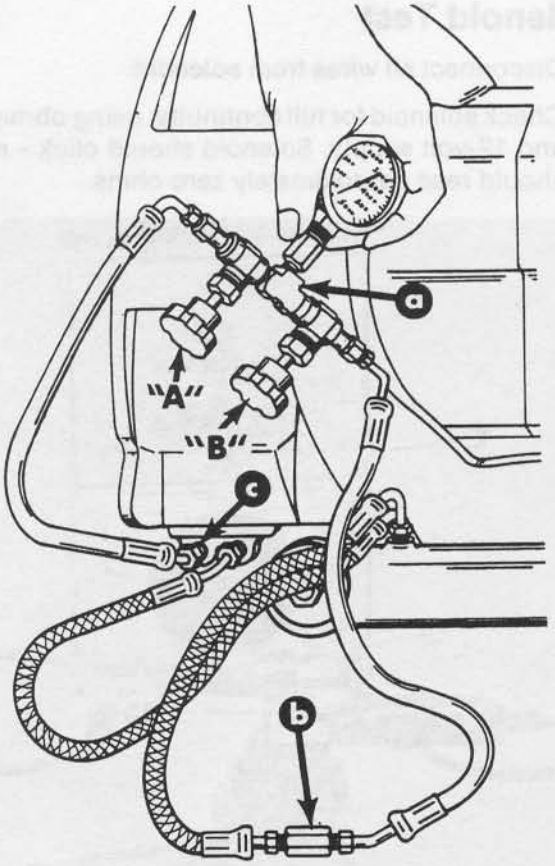
IMPORTANT: The following test assumes that pump "Out"/"Up" pressure is within specifications as determined by performing "Power Trim Pump Test".

1. Connect gauge at most convenient location.



a - Hydraulic Test Gauge 91-52915A3
b - Fitting (22-77366)
c - Fittings (Supplied with Gauge)
d - Black Hydraulic Hose — From Gimbal Housing
e - Gray Hydraulic Hose — From Gimbal Housing

Gauge Connected at Pump



a - Test Gauge
b - Coupling (Suppled with Gauge)
c - Front Hydraulic Connector Port

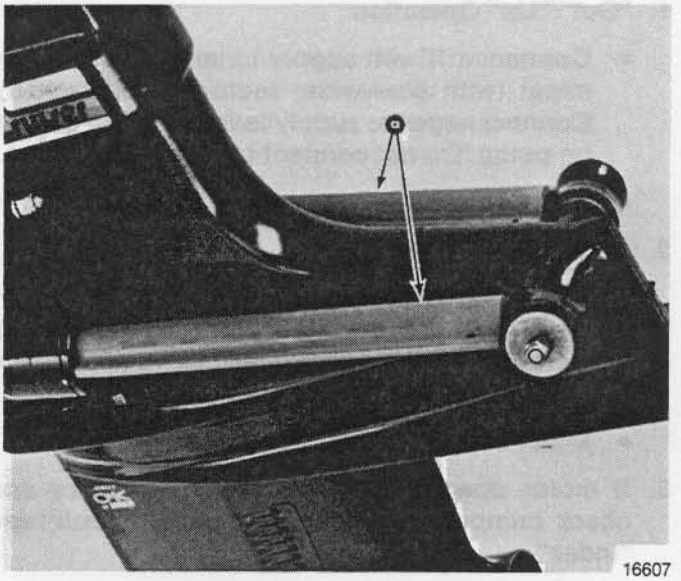
Gauge Connected at Hydraulic Connector

2. Open valve "A" and "B" and run pump "Out"/"Up" and "In"/"Down" several times (to purge air).
3. Run pump "Out"/"Up" until trim cylinders are fully extended: then, observe gauge while pumping. Pressure should be 2200-2600 psi (15173-17932 kPa).
4. Stop pumping "Out"/"Up". Pressure should not fall below 1900 psi (13104 kPa).
5. If readings are now within specifications, an internal trim cylinder leak is indicated. Use the following procedure to locate faulty cylinder.
   a. If gauge is connected at pump, reconnect gauge at gimbal housing hydraulic connector. Repeat Step 2; then, run pump in "Out"/"Up" direction until trim cylinder is fully extended.
   b. Close Valve "B" on test gauge and repeat Steps 3 and 4.
      - If readings are now within specifications, trim cylinder, on same side of drive unit as gauge, is faulty.
      - If readings are still not within specifications, trim cylinder, on opposite side of drive unit as gauge, is faulty.

Trim Cylinder Shock Piston Test

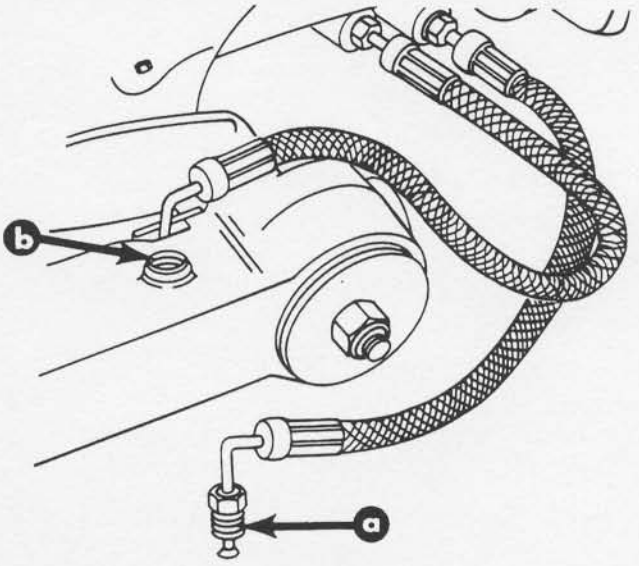
If trim system checks out good, but drive unit will not trim "In"/"Down", problem may be due to a leaky trim cylinder shock piston. Use the following test to check for this condition. Test gauge is not required.

1. Run pump in "Out"/"Up" direction until trim cylinders are fully extended.
2. Prevent trim cylinder piston rods from retracting, using a suitable device. Quicksilver Trailering Kit 41155A1 works well for this purpose.



a - Trailering Kit 41155A1

3. Disconnect "Up" trim hose from trim cylinders.



a - "Up" Trim Hose
b - Front Connection

4. Run pump in "In"/"Down" direction. If oil flows from "Up" port on trim cylinder, shock piston is leaking and must be replaced.

Motor and Electrical Bench Tests

Trim Pump Motor Test

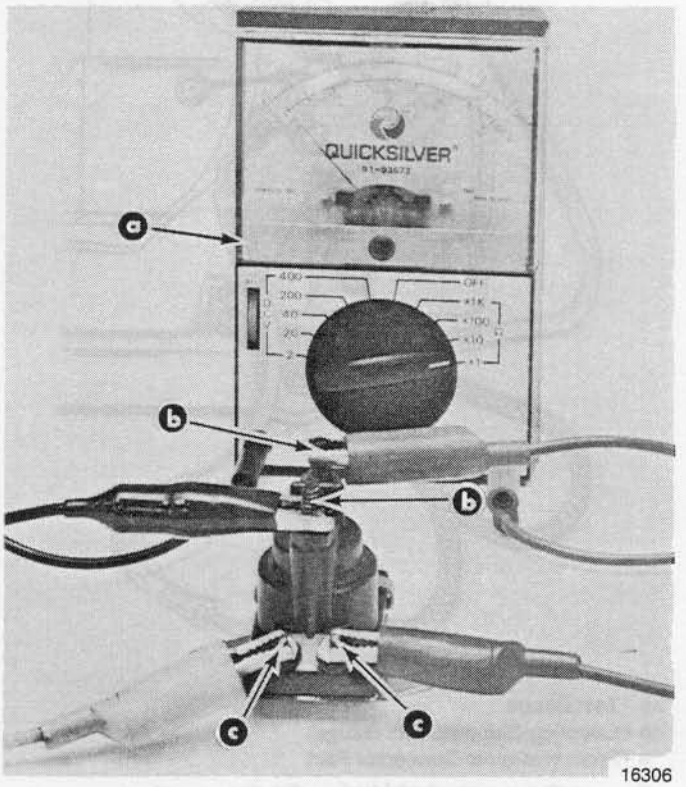
⚠WARNING

DO NOT perform this test near flammables (or explosives). as a spark may occur when making connections. Remove pump from boat, if necessary, before performing test.

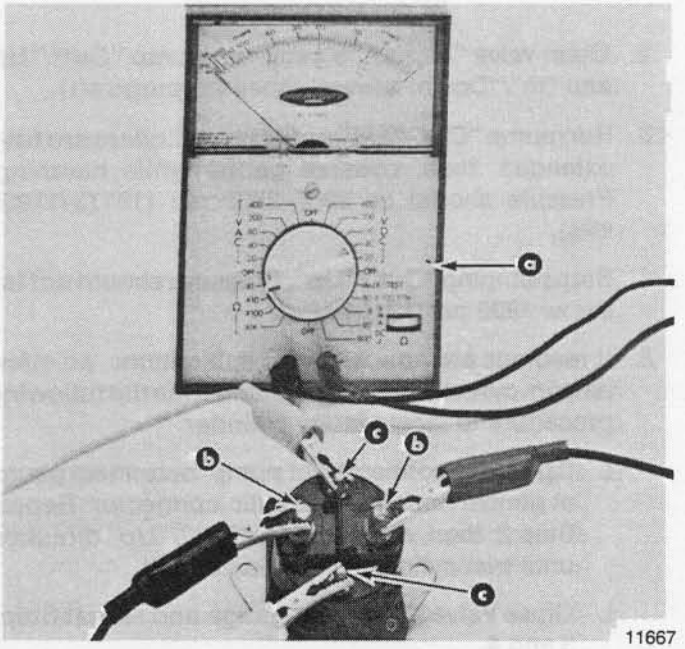
1. "Out"/"Up" Operation.
   - Connect a 12 volt supply to large solenoid terminal (with blue-white motor lead attached). Connect negative supply lead to a good ground on pump. Do not connect to black motor lead.
   - Motor should run.
2. "In"/"Down" Operation.
   - Connect a 12 volt supply to large solenoid terminal (with green-white motor lead attached). Connect negative supply lead to a good ground on pump. Do not connect to black motor lead.
   - Motor should run.
3. If motor does not run, disassemble motor and check components. Refer to "Motor Repair" see "Index".

Solenoid Test

1. Disconnect all wires from solenoid.
2. Check solenoid for full continuity, using ohmmeter and 12-volt supply. Solenoid should click - meter should read approximately zero ohms.



16306



11667

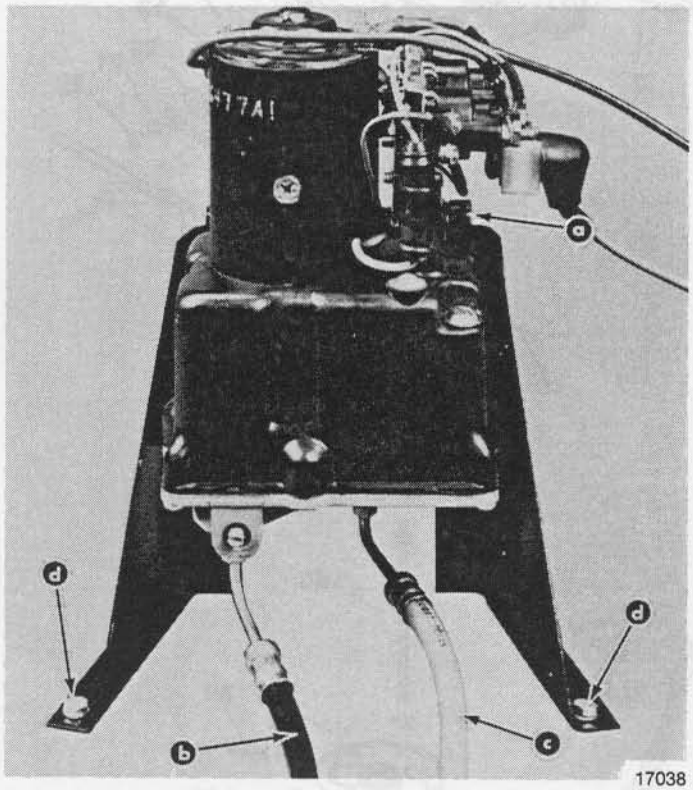
a - Ohmmeter - Rx1 Scale
b - Ohmmeter Leads
c - 12-Volt Supply (Leads)

3. **Zero ohms read (full continuity)** - solenoid OK.
   High ohm reading (no continuity) - replace solenoid.

Trim Pump Removal and Installation

Removing Trim Pump From Boat

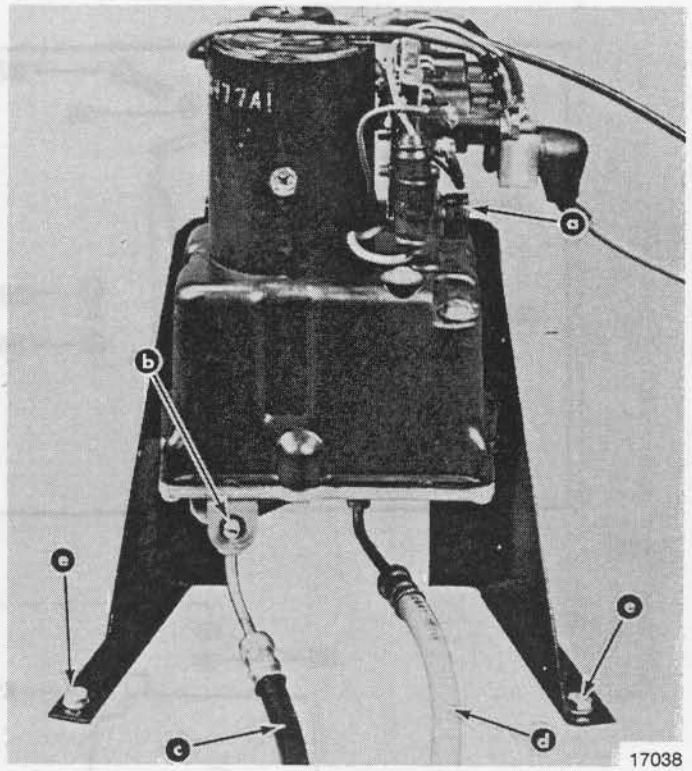
1. • Disconnect trim pump battery cables from battery (negative lead first).
   • Disconnect trim harness from trim pump.
   • Remove trim hoses from pump. Cap end of hoses; plug ports in pump.
   • Remove lag bolts and washers, and lift pump and mounting bracket from boat.



a - Harness Connector
b - Black Hydraulic Hose
c - Gray Hydraulic Hose — From Gimbal Housing
d - Lag Bolts and Washers

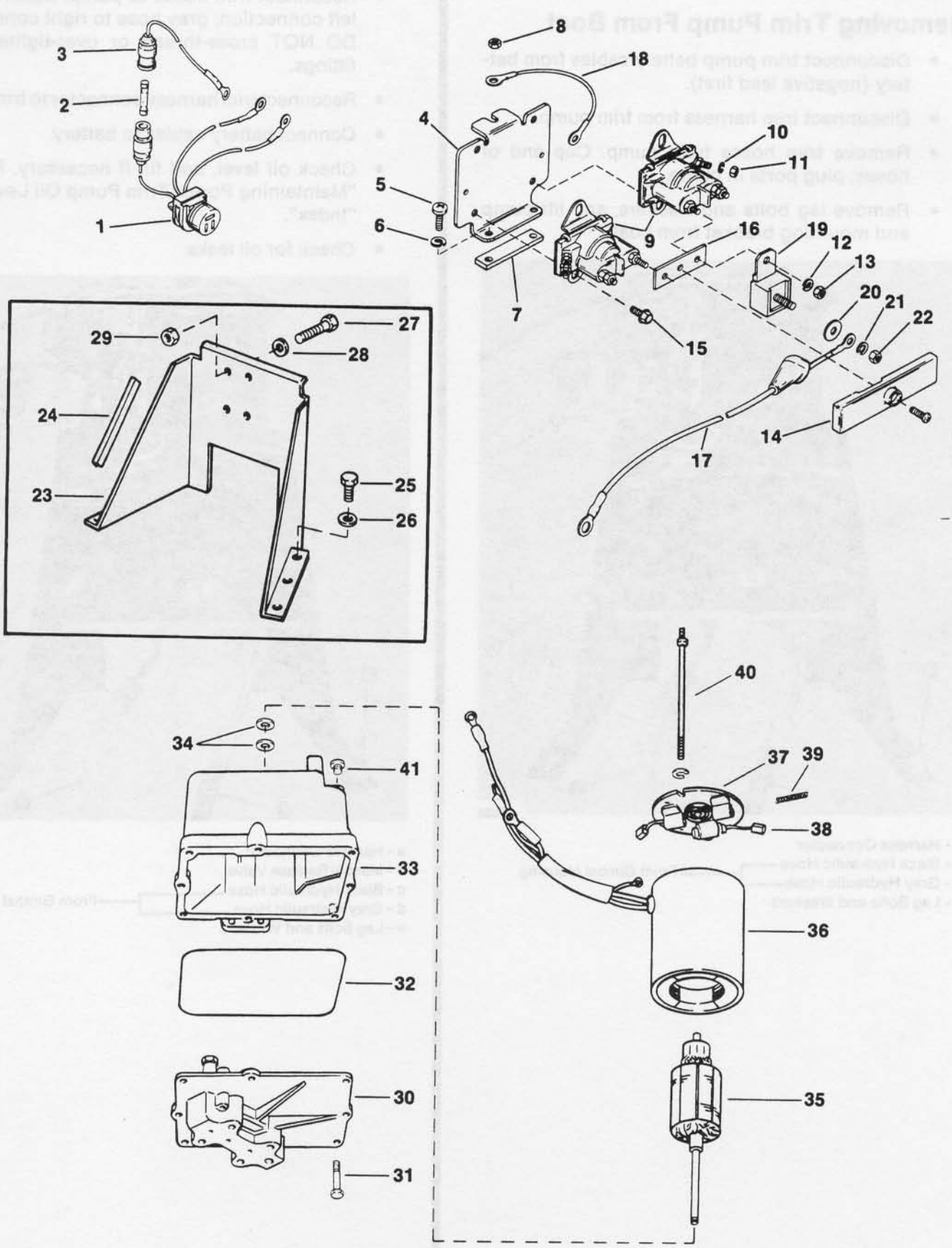
Installing Trim Pump

1. • Secure pump and mounting bracket to boat, using lag bolts and washers.
   • Reconnect trim hoses to pump. Black hose to left connection; gray hose to right connection. DO NOT cross-thread or over-tighten hose fittings.
   • Reconnect trim harness connector to trim pump.
   • Connect battery cables to battery.
   • Check oil level, and fill if necessary. Refer to "Maintaining Power Trim Pump Oil Level", see "Index".
   • Check for oil leaks.



a - Harness Connector
b - Manual Release Valve
c - Black Hydraulic Hose
d - Gray Hydraulic Hose — From Gimbal Housing
e - Lag Bolts and Washers

Prestolite Power Trim Pump - Exploded Parts View



1 - Connector and Harness
2 - Fuse (20 Amp)
3 - Wire, fuse
4 - Bracket, mounting - solenoid
5 - Screw, mounting bracket to resevoir
6 - Lockwasher, mounting bracket screw
7 - Spacer, mounting bracket screw
8 - Nut, mounting bracket to pump motor
9 - Solenoid
10 - Lockwasher, solenoid terminal
11 - Nut, solenoid terminal
12 - Lockwasher, solenoid terminal
13 - Nut, solenoid terminal
14 - Boot, rubber positive battery cable
15 - Screw, solenoid to mounting bracket
16 - Link, solenoid to solenoid
17 - Battery Cable (Positive +)
17 - Battery Cable (Negative -)
18 - Wire, solenoid (Black)
19 - Fuse (110 Amp)
20 - Washer, fuse terminal
21 - Lockwasher, fuse terminal
22 - Nut, fuse terminal
23 - Bracket Assembly, mounting-hydraulic pump
24 - Bumper, rubber-pump mounting bracket
25 - Screw, pump mounting bracket
26 - Washer, pump mounting bracket screw
27 - Screw, hydraulic pump to mounting bracket
28 - Lockwasher, hydraulic pump screw
29 - Nut, hydraulic pump screw
30 - Valve Body and Gear Assembly
31 - Screw, valve body to reservoir
32 - Seal, reservoir to valve body and gear assembly
33 - Reservoir Assembly
34 - Washer, thrust-armature
35 - Armature, field and frame
36 - Field and Frame Assembly
37 - Plate Assembly, commutator end
38 - Brush Set, commutator end plate
39 - Spring Set, brush tension
40 - Bolt Set, thru
41 - Fill Plug, reservoir

Hydraulic Repair

⚠CAUTION

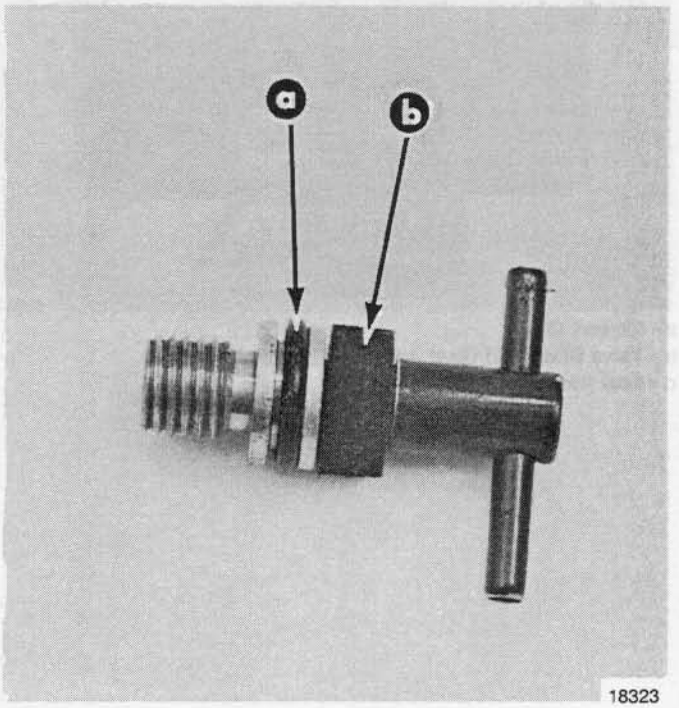
Work area must be dirt-and-lint free. The slightest amount of dirt in hydraulic system can cause pump malfunction.

Manual Release Valve Replacement

⚠WARNING

Before loosening the manual release valve, make sure all people are clear of drive unit as drive unit will drop to full "In"/"Down" position when valve is loosened.

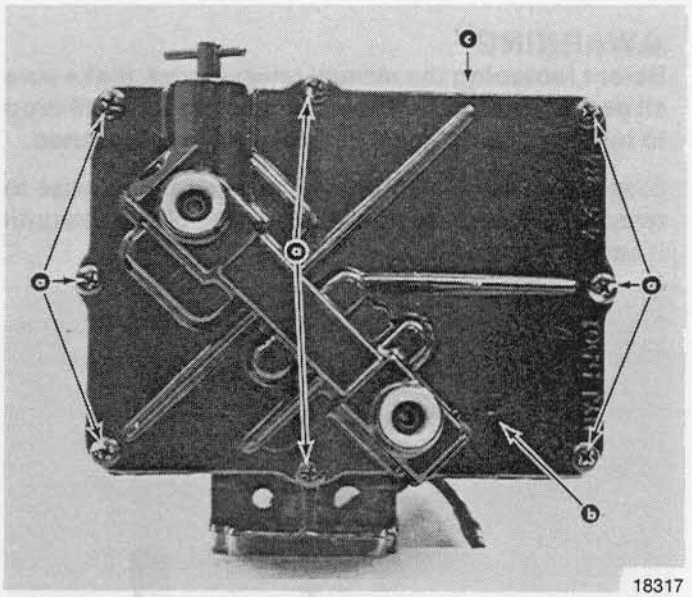
Slowly turn manual release valve counterclockwise to remove. To install new valve, turn valve clockwise until it seats.



a - "O" Ring
b - Rubber Seal

Valve Body and Gear Assembly Replacement

1. Place pump in a container to catch oil when valve body and gear assembly is removed.
2. Remove and replace valve body and gear assembly and seal.



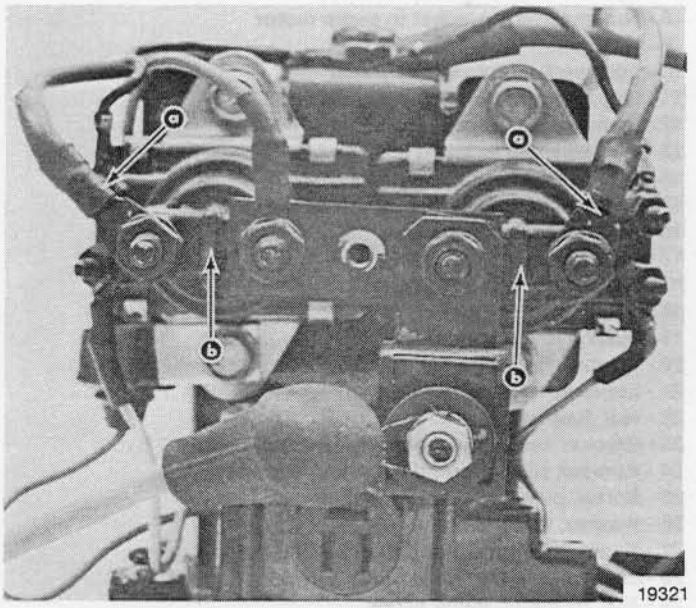
18317

a - Screws (8)
b - Valve Body and Gear Assembly
c - Seal (Not Seen) - Replace

Motor Repair

Removal and Disassembly

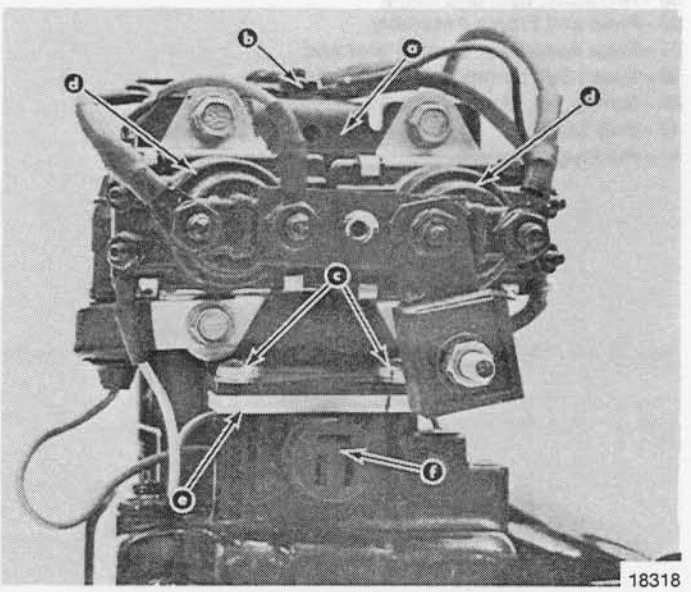
1. Disconnect trim pump motor leads.



19321

a - Trim Pump Motor Leads
b - Solenoids

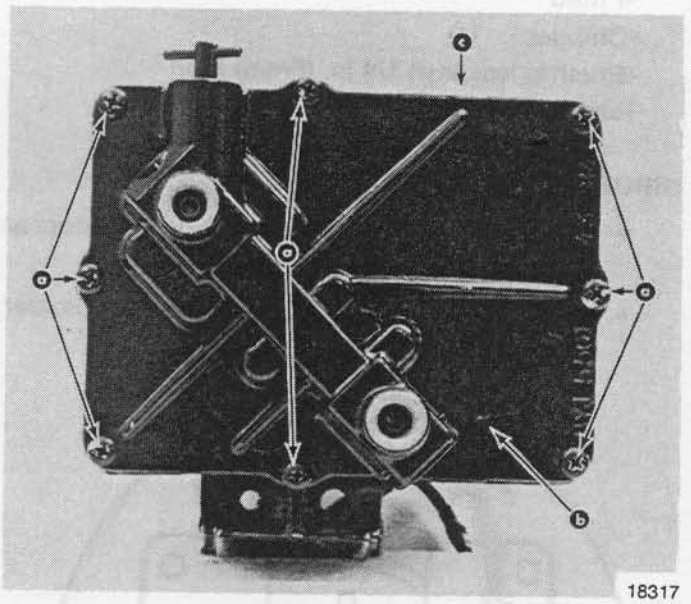
2. Remove solenoid plate and connector and harness.



18318

a - Solenoid Plate
b - Nut
c - Screws
d - Solenoids
e - Spacer
f - Connector and Harness

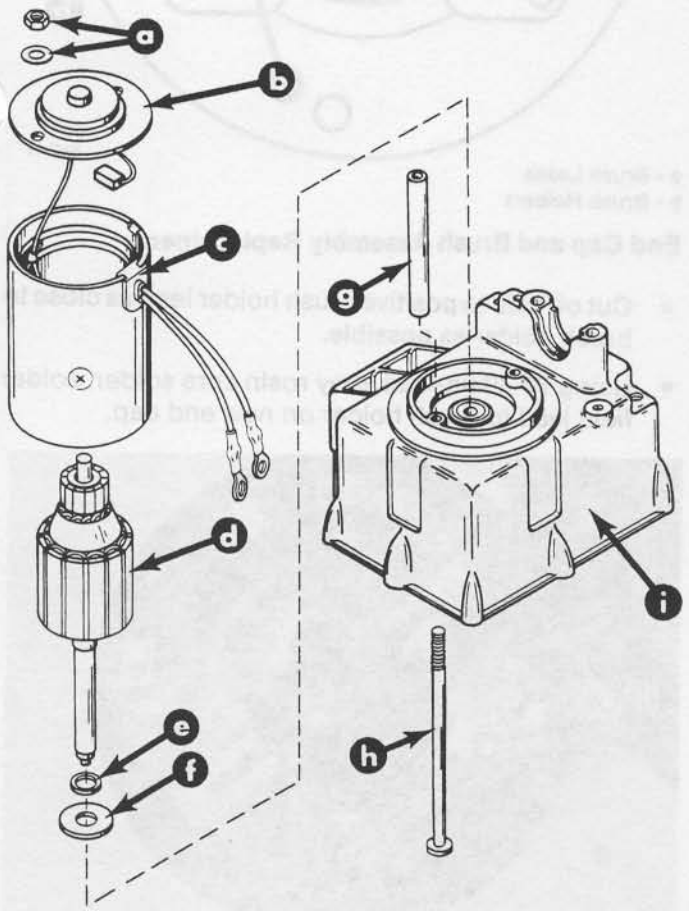
3. Remove valve body and gear assembly.



18317

a - Screws (8)
b - Valve Body and Gear Assembly
c - Seal (Not Seen)

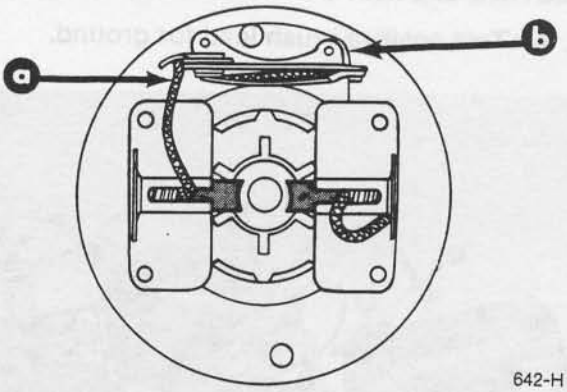
4. Remove motor assembly.



a - Nut and Washer (2)
b - End Plate Assembly
c - Field and Frame Assembly
d - Armature
e - Small Thrust Washer(s)
f - Large Thrust Washer
g - Spacer (1)
h - Studs (2)
i - Reservoir

Thermal Circuit Breaker Test

1. Test thermal circuit breaker for continuity, using ohmmeter set on RX1 scale.



642-H

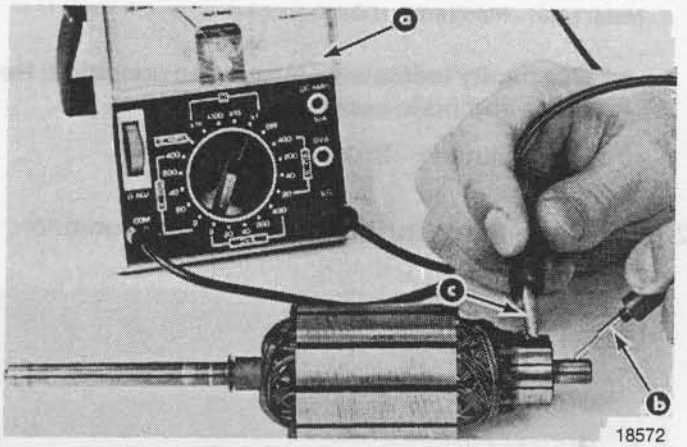
a - Place Meter Lead at This Point b - Place Meter Lead at Ground

2. **Continuity indicated -** Circuit breaker OK.
   Continuity not indicated - Circuit breaker open; replace cap.

Armature Tests

TEST FOR GROUND

1. Check armature for continuity.



18572

a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Armature Shaft
c - Meter Lead - Place on All Commutator Bars (One-at-a-time)

2. **Continuity indicated -** Armature is grounded; replace armature.

   Continuity not indicated - Armature not grounded.

TEST FOR SHORTS

Check armature on a growler (follow growler manufacturer's test instructions). Indication of short requires armature replacement.

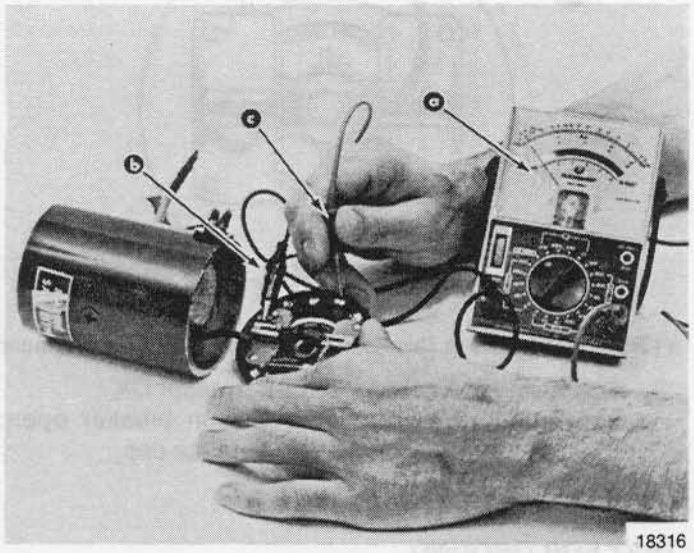
CHECKING and CLEANING COMMUTATOR

1. If commutator is worn, turn down on an armature conditioner tool or lathe.
2. Clean commutator with "OO" garnet grit sandpaper. DO NOT use emery paper.

Brush Lead Testing and Brush Replacement

TESTING and INSPECTING BRUSHES and LEADS

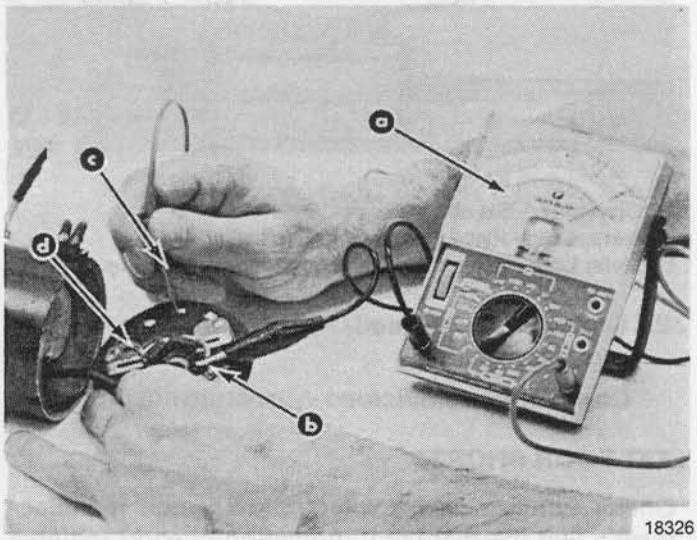
1. • Test positive brush lead for ground.



a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Positive Brush Lead
c - Meter Lead - Place on End Cap

- **Continuity indicated** - Grounded condition; Replace end plate assembly.
- **No continuity** - Brush lead OK.

2. • Test negative brush lead for an open condition.



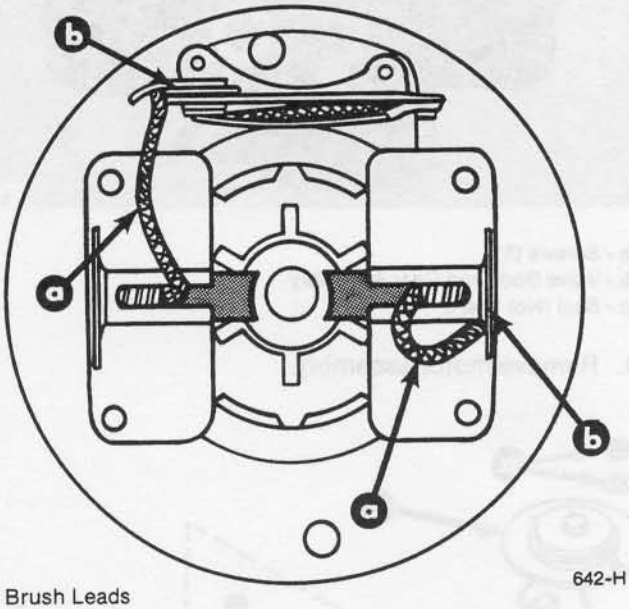
a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Negative Brush Lead
c - Meter Lead - Place on End Cap
d - Positive Brush Lead

- **Continuity indicated** - Brush lead OK.
- **Continuity NOT indicated** - Inspect lead for a poor connection.

3. Inspect brushes and replace if:
   - -Pitted
   - -Chipped
   - -Brush is less than 1/4 in. (6mm) long
   - -Leads are fraying

BRUSH REPLACEMENT

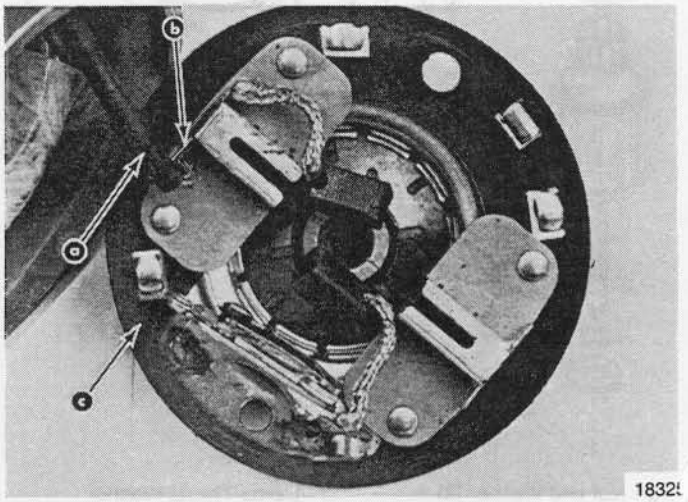
- Cut brush leads off as close to brush holders as possible.
- Using 70-30 tin-lead alloy rosin core solder, solder new brushes to brush holders.



a - Brush Leads
b - Brush Holders

End Cap and Brush Assembly Replacement

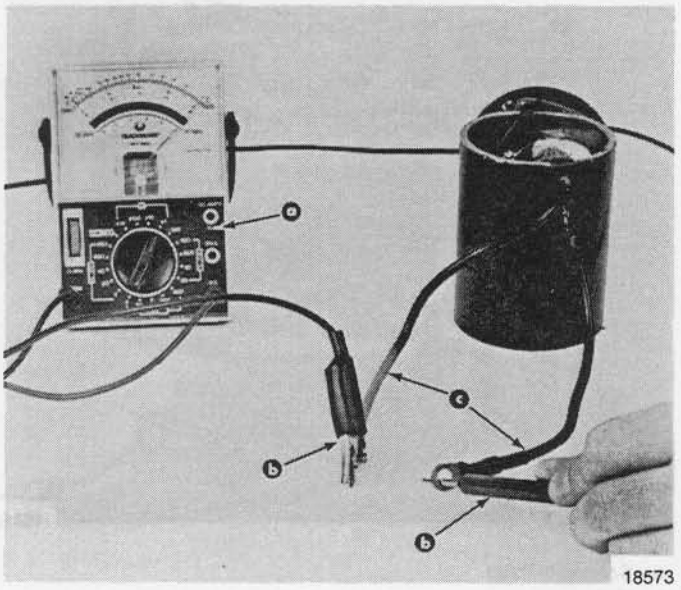
- Cut off field to positive brush holder lead as close to brush holder as possible.
- Using 70-30 tin-lead alloy rosin core solder, solder field lead to brush holder on new end cap.



a - Field Lead
b - Positive Brush Holder
c - End Cap

Field Tests

1. • Check field for open condition.



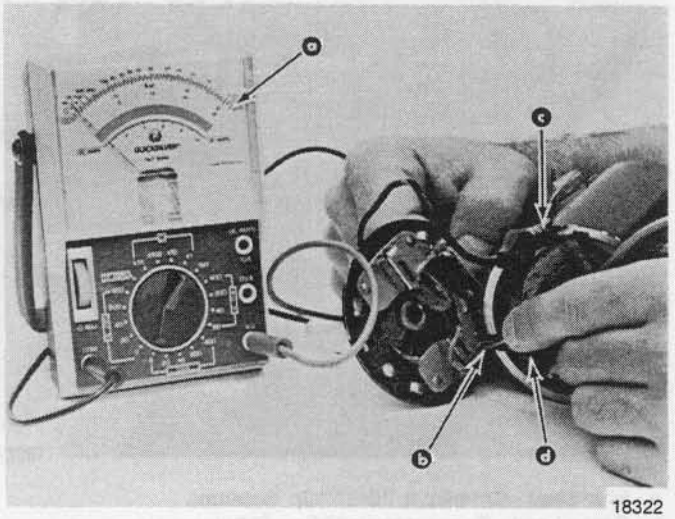
18573

a - Ohmmeter - Set on Rx1 Scale
b - Meter Leads - Connect Between Field Leads
c - Field Leads

Continuity indicated - field OK.

No continuity - field open; replace field and frame assembly.

2. Check field for grounded condition.



18322

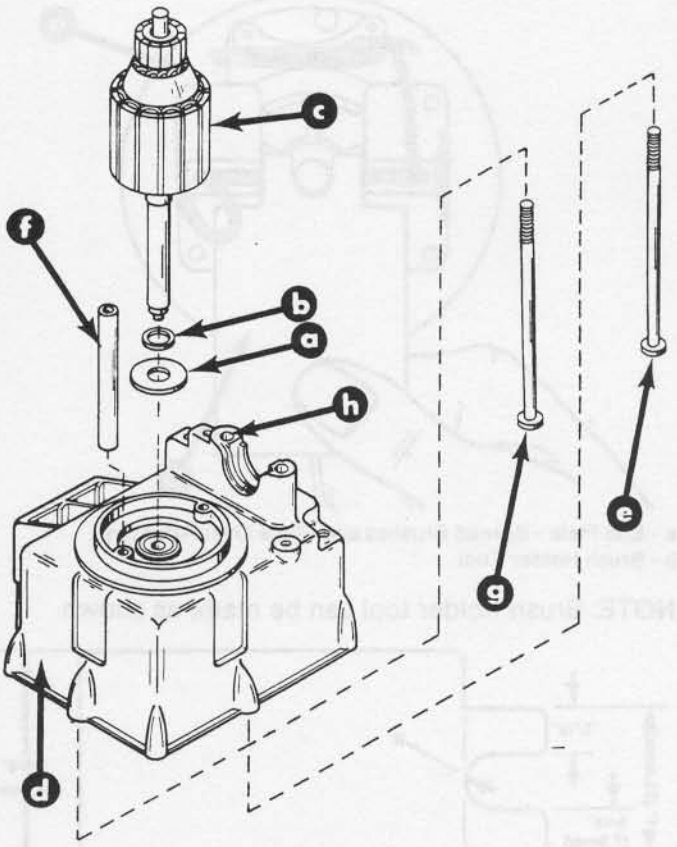
a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Positive Brush Holder Lead
c - Meter Lead - Place on Frame
d - Field Lead

Continuity indicated - field grounded; replace field and frame assembly.

Continuity NOT indicated - field OK.

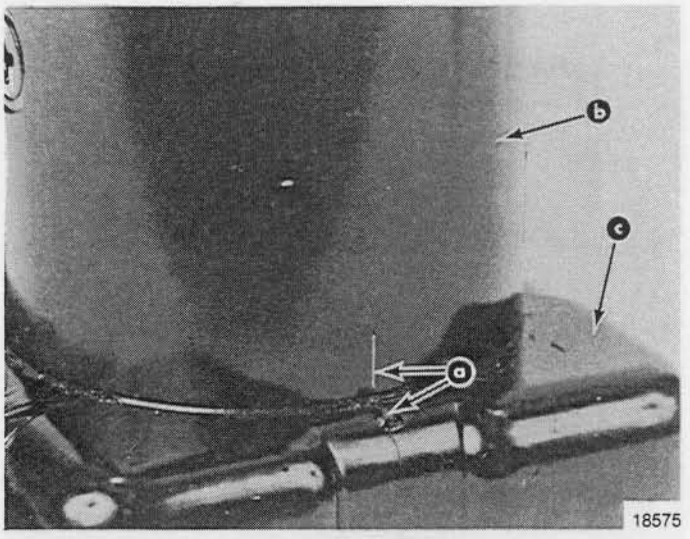
Reassembly and Installation

1. Install armature and washers.



a - Large Washer
b - Small Washer(s)
c - Armature
d - Reservoir
e - Long Stud
f - Sleeve (1)
g - Small Stud
h - Connector and Holder

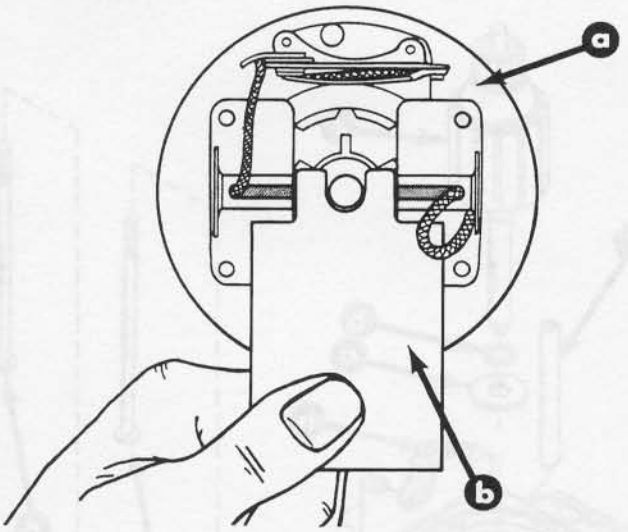
2. Install field and frame assembly. Align index mark on field and frame assembly with mark on reservoir.



18575

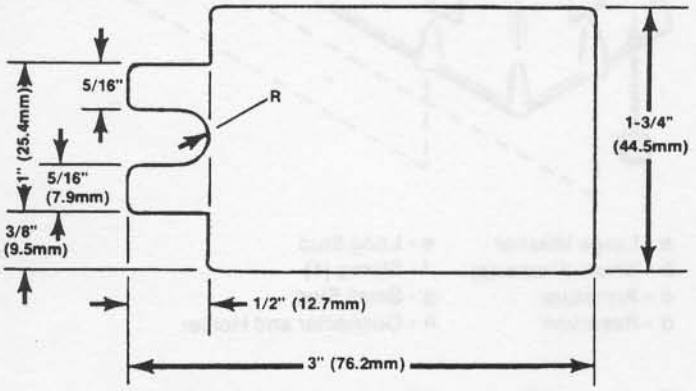
a - Index Marks - Align
b - Field and Frame Assembly
c - Reservoir

3. Spread brushes with brush holder tool and install end plate over armature. Secure end cap with nuts and washers.

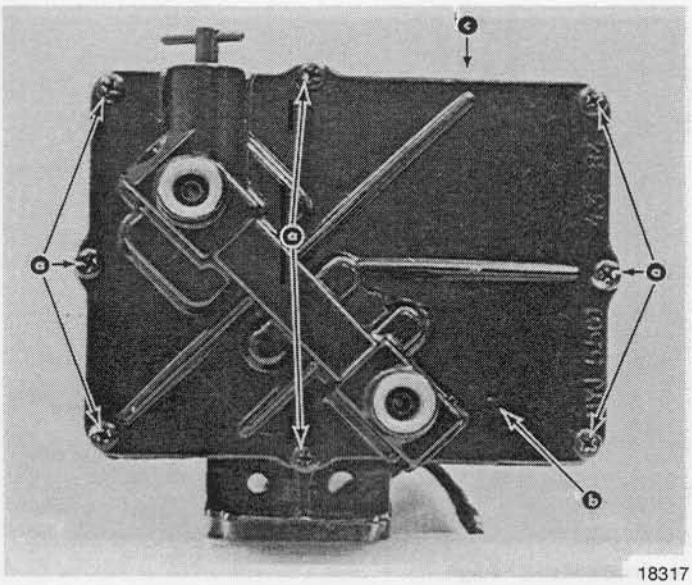


a - End Plate - Spread Brushes and Place Over Armature
b - Brush Holder Tool

NOTE: Brush holder tool can be made as shown.

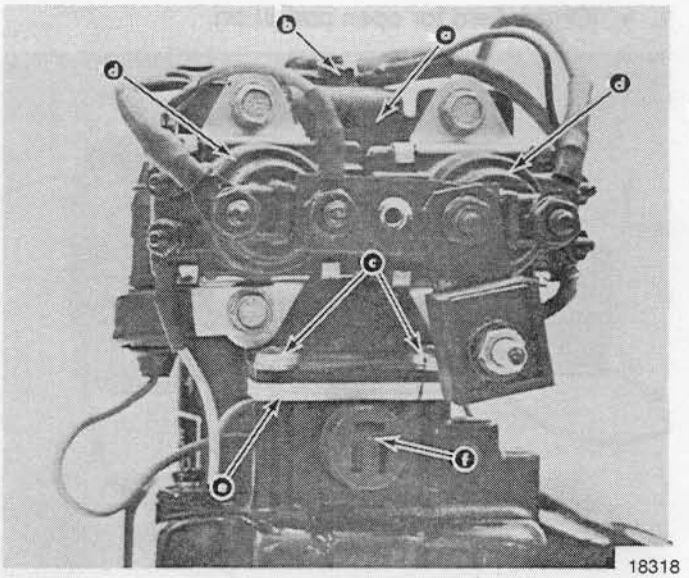


4. Install canister.
5. Install valve body and gear assembly.



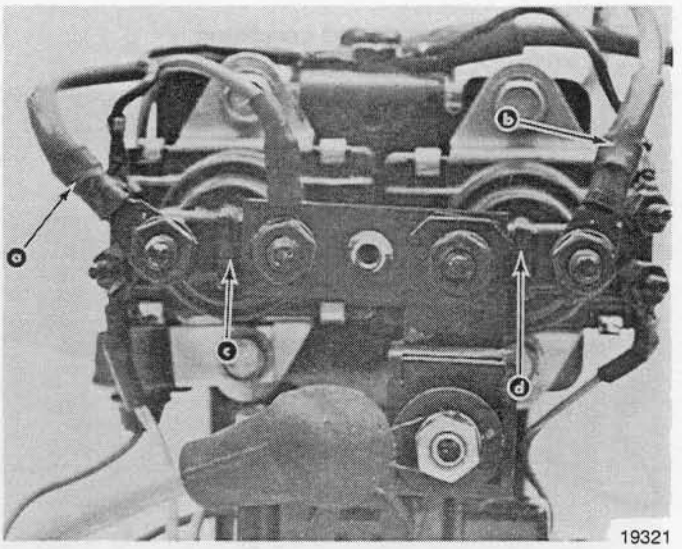
a - Screws (8)
b - Valve Body and Gear Assembly
c - New Seal (Not Seen)

6. Install solenoid plate and connector and harness.



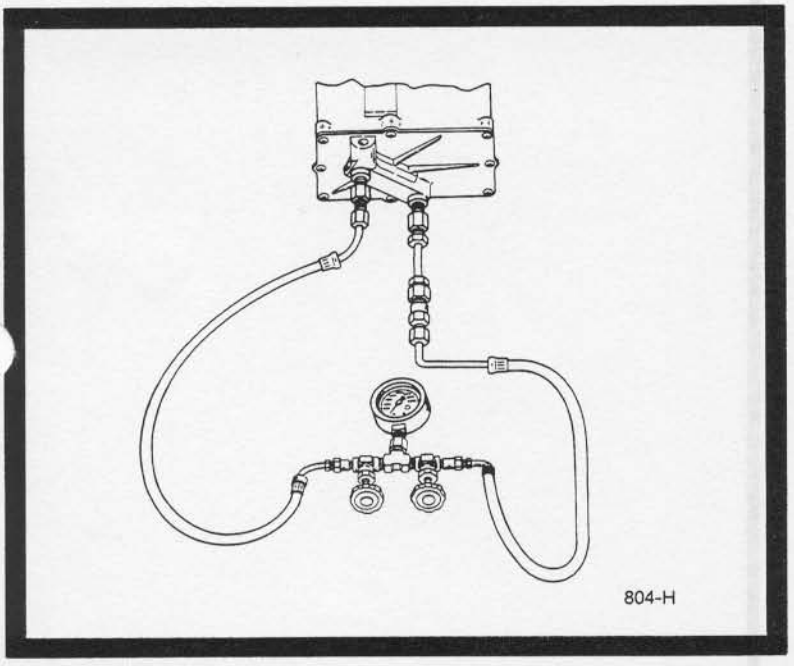
a - Solenoid Plate
b - Nut
c - Screws
d - Solenoids
e - Spacer
f - Connector and Harness

7. Secure trim pump motor leads to solenoids.



a - Blue Lead - Connect to "Out"/"Up" Solenoid
b - Green Lead - Connect to "In"/"Down" Solenoid
c - "Out"/"Up" Solenoid
d - "In"/"Down" Solenoid

POWER TRIM



PRESTOLITE HIGH PRESSURE POWER TRIM PUMP

5
C

mercruiser
STERN DRIVES & INBOARDS

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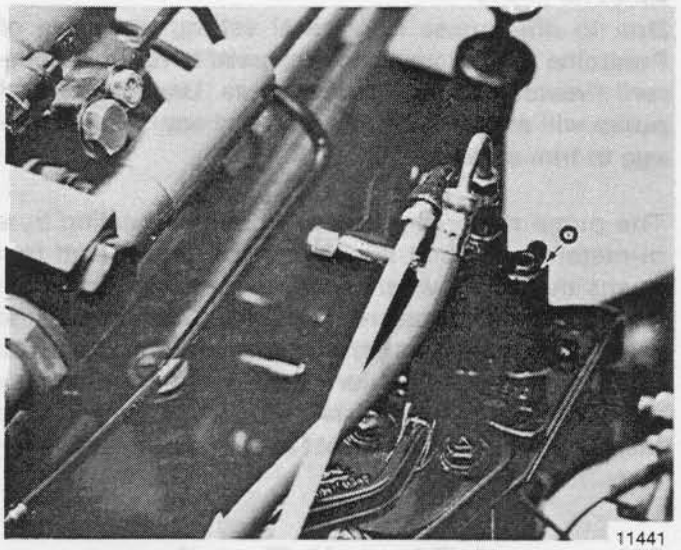
Identification

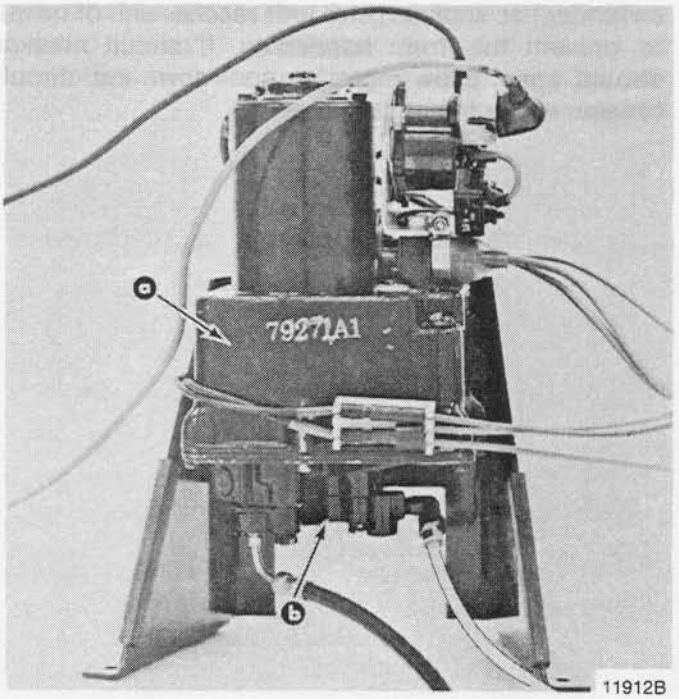
Early MerCruiser Stern Drives were equipped with a high pressure, low volume Prestolite Power Trim pump. This pump and the Power Trim system differ from the low pressure, high volume trim system currently used. The Power Trim system, utilitzing this high pressure low volume pump, can be readily identified by the presence of an external reverse lock valve. (Figure 1)



a - Reverse Lock Valve

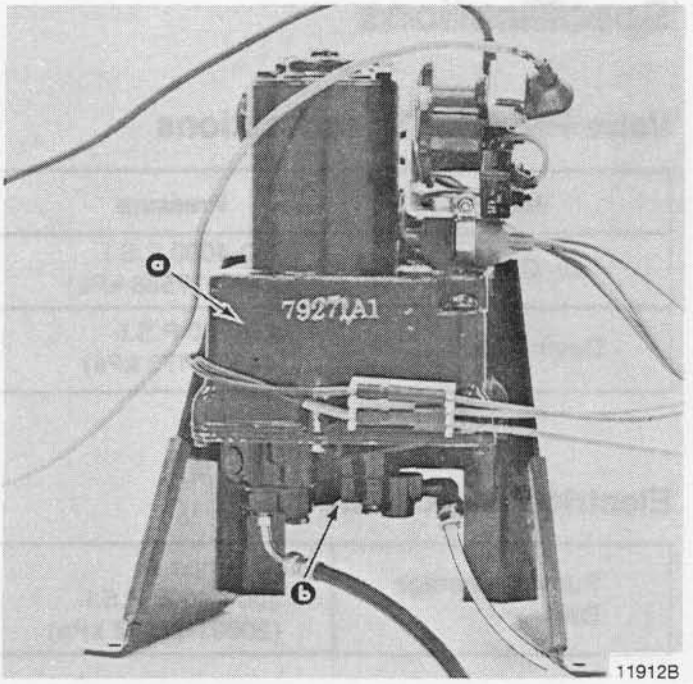
Figure 1. Prestolite High Pressure, Low Volume System Idnetification

Three styles of Prestolite pump were used with this system. They are shown in Figures 2, 3 and 4.



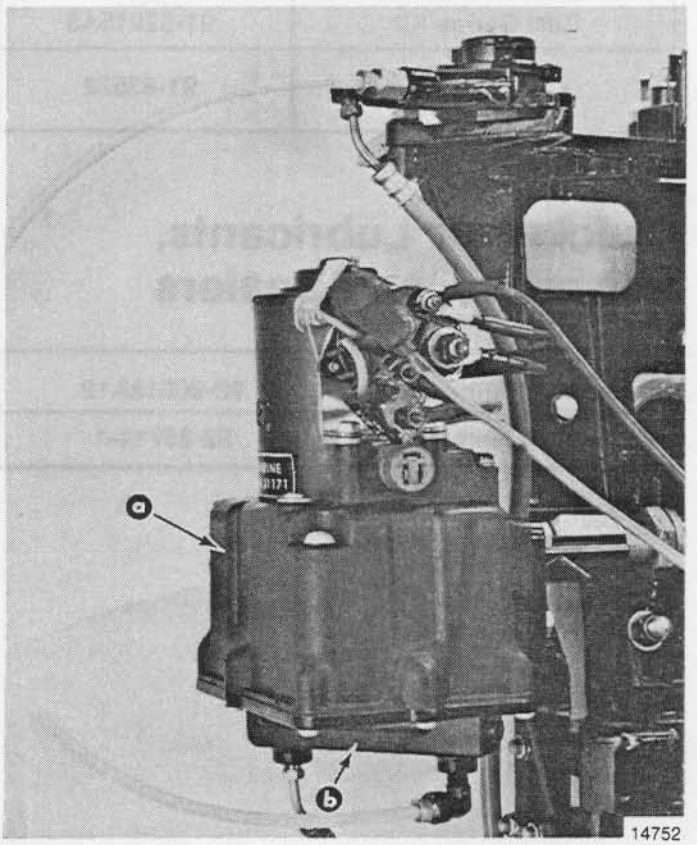
a - Metal Reservoir
b - External Control Valve

Figure 2. Prestolite Power Trim Pump with Metal Reservoir and External Control Valve



a - Plastic Reservoir
b - External Control Valve

Figure 3. Prestolite Power Trim Pump with Plastic Reservoir and External Control Valve



a - Plastic Reservoir
b - Integral Control Valve

Figure 4. Prestolite Power Trim Pump with Plastic Reservoir and Integral Control Valve

Unlike the low pressure pump currently used, the integral control valve style high pressure pump does not have a Manual Release Valve.

Specifications

Valve Pressure Specifications

Valve	Pressure
Up Circuit	3000-4000 P.S.I. (20691-27588 kPa)
Down Circuit	650-750 P.S.I. (4483-5173 kPa)

Electrical Specification

Pump Amperage Draw	90 Amps at 3000-4000 P.S.I. (20691-27588 kPa)

Special Tools

Test Gauge Kit	91-52915A3
Multi-Meter (Ohmmeter)	91-93572

Quicksilver Lubricants, Adhesives, and Sealers

2-4-C Multi-Lube	92-90018A12
Liquid Neoprene	92-25711-1

Description

The early Prestolite Power Trim Pump generates a lower volume of fluid, but at a higher pressure than Prestolite pumps currently used. This system incorporates an external reverse lock valve that prevents upward travel of drive unit that is caused by propeller thrust in reverse gear.

⚠CAUTION

Due to differences in internal valving, this type of Prestolite trim pump cannot be used to replace a current Prestolite pump, or vice-versa. Use of incorrect pump will affect trim operation and may cause damage to trim system.

The pump motor is protected from overheating by a bi-metal switch that is built into the brush lead that opens the circuit when the temperature of the brush lead becomes excessive. As the motor cools, the switch will close to permit normal operation. Electrical curent overload protection is provided to the pump by a 90 amp fuse. Pump also is fitted with a 20 amp in-line fuse, which serves to protect the trim control and harness from an overload.

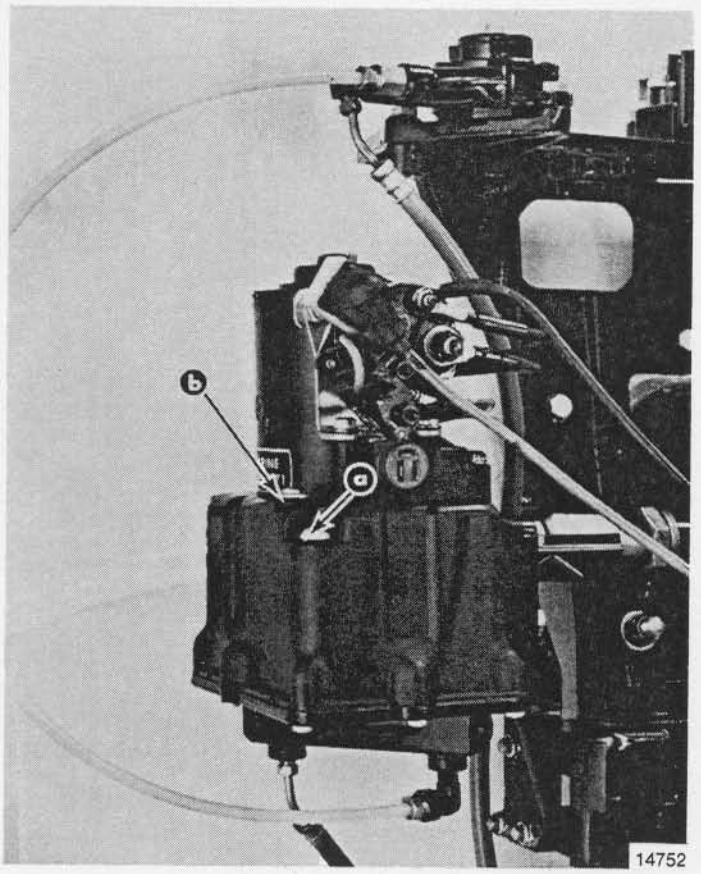
Thermal Circuit Breaker Operation

If the "In"/"Down" or "Trailer" switch is kept depressed after drive unit reaches its end of travel, a thermal circuit breaker will open to prevent pump motor from overheating and pump motor will stop. Release switch(es) as soon as drive unit reaches end of travel, to prevent this from happening. If circuit breaker should open, allow motor to cool down and circuit breaker will automatically reset.

Maintaining Power Trim Pump Oil Level

1. Place drive unit in the full "In"/"Down position.
2. • Remove "Fill" screw from pump.
   • Oil level should be up to bottom of the threads in "Fill" screw hole. If necessary, add SAE 10W30 or 10W40 motor oil (thru "Fill" screw hole).

NOTE: In tropical areas, single viscosity SAE30 motor oil can be used.



a - Fill Screw
b - Vent Screw

3. Raise and lower drive unit 6 to 10 times to purge any air from system; then, recheck oil level (with drive unit fully "In"/"Down") and add oil if necessary.

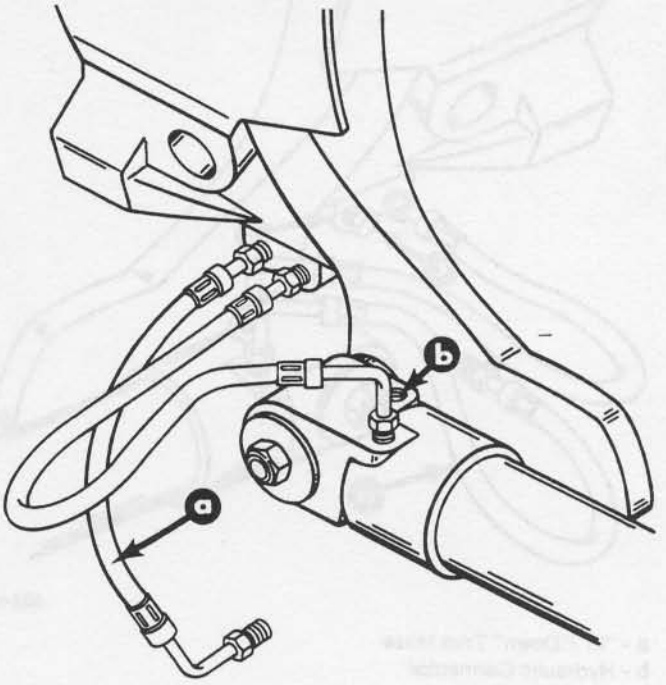
⚠CAUTION

"Vent" screw must be backed out 2 full turns to vent pump reservoir. FAILURE TO VENT RESERVOIR COULD AFFECT PUMP OPERATION and/or CAUSE DAMAGE TO SEALS AND "O" RINGS.

Air Bleeding Power Trim System

The Power Trim system will purge itself of a small amount of air by raising and lowering the drive unit several times. However, if a rebuilt trim cylinder is being installed (which has not been filled with oil), the following bleeding procedure should be used to remove the air from the system.

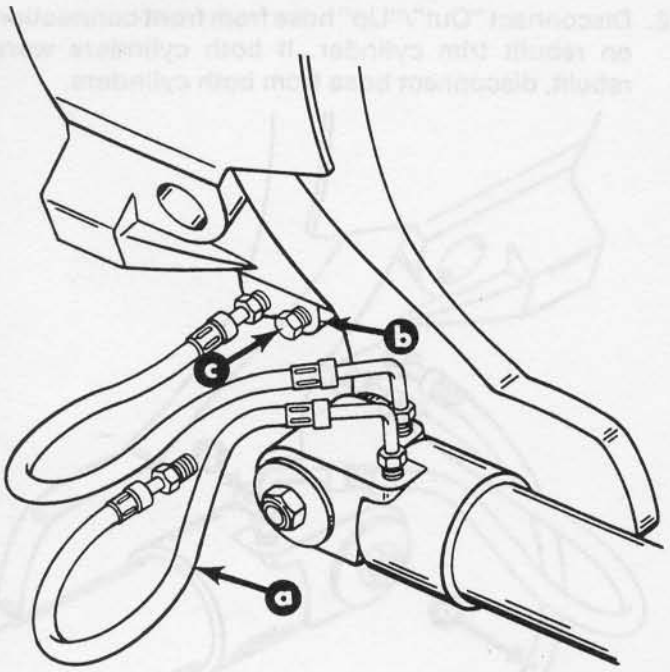
1. With drive unit in the full "In"/"Down" position, remove fill screw and fill trim pump to bottom of fill screw threads with SAE 10W30 or 10W40 motor oil.
2. Disconnect "Out"/"Up" hose from front connection on rebuilt trim cylinder. If both cylinders were rebuilt, disconnect hose from both cylinders.



a - "Out"/"Up" Trim Hose
b - Front Connection on Trim Cylinder

Bleeding "Out"/"Up" Trim Circuit

3. Direct end of trim hose(s) into a container; then, run trim pump in the "Out"/"Up" direction until a solid, air-free stream of oil is expelled from hose(s). Reconnect hose(s) and tighten securely.
4. Refill trim pump to proper level.
5. • Disconnect "In"/"Down" trim hose from rear connection on gimbal housing hydraulic connector. If both cylinders were rebuilt, disconnect both hoses from aft connection on both sides of connector.
   • Plug port(s) in hydraulic connector, using plug (22-38609) or a suitable device.



804-H

a - "In"/"Down" Trim Hose
b - Hydraulic Connector
c - Plug (22-38609)

Bleeding "In"/"Down" Trim Circuit

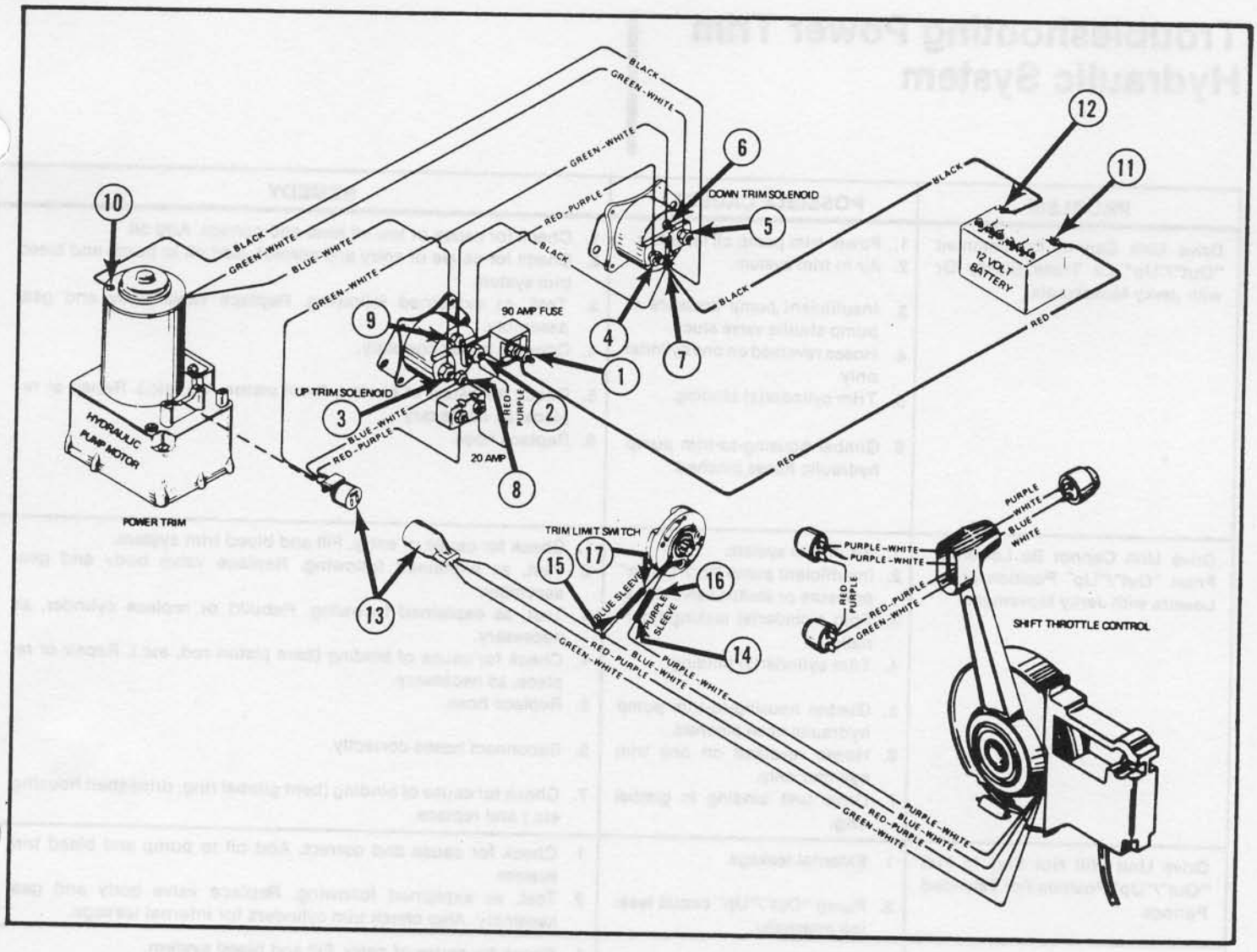
6. Direct end of trim hose(s) into a container. Run trim pump in the "Out"/"Up" direction until trim cylinders are fully extended. If both cylinders are being bled, pump must be refilled with oil when cylinders are extended about half-way, to prevent pump from running out of oil.
7. Remove plug(s) from gimbal housing hydraulic connector and momentarily run trim pump in the "In"/"Down" direction until a solid, air-free stream of oil is expelled from connector. Reconnect trim hose(s) and tighten securely.
8. Lower drive unit to the full "In"/"Down" position and refill trim pump to proper level. Run trim system "In"/"Down" and "Out"/"Up" several times and recheck oil level.

Troubleshooting Power Trim Electrical System

NOTE: Refer to wiring diagram, following, for assistance in electrical system troubleshooting.

PROBLEM	POSSIBLE CAUSES	REMEDY
Power Trim Pump Motor Will Not Run in The "Out"/"Up" or "In"/"Down" Direction -- **Solenoids Do Not Click** *Does not apply to an intermittent problem.	1. Thermal circuit breaker in pump motor open 2. *20 amp fuse blown. 3. Power trim pump battery cables or wiring harness connections corroded or loose. 4. Trim control wiring harness connector loose or corroded. 5. *110 amp fuse blown. 6. Open circuit in trim control wiring harness.	1. Replace commutator end plate assy. 2. Determine cause for blown fuse and correct before replacing fuse. *NOTE: If fuse blows while trimming "Out"/"Up" or raising drive unit, problem may be due to grounded trim limit switch leads.* To check for grounded condition, disconnect trim limit switch leads at bullet connector "14", "15", "16", and "17" (in wiring diagram). If drive unit can now be raised (using "Trailer" switch), trim limit switch or leads are grounded. 3. Clean and/or tighten connections "1", "2", "4", "10", "11" and "12", as necessary. 4. Clean and secure connection "13", as necessary. 5. Check for voltage at terminal "2". If no voltage is indicated, determine cause for blown fuse and correct, then replace fuse. (Trimming "Out"/"Up" and "In"/"Down" simultaneously will blow fuse.) 6. Check for battery voltage at terminal "8" while trimming "Out"/"Up" and at terminal "6" while trimming "In"/"Down". If no voltage is indicated, check trim control for a loose or corroded connection or a damaged power supply lead in harness.
Power Trim Pump Will Not Run In The "Out"/"Up" or "In"/"Down" Direction -- **Both Solenoids Click**	1. Faulty solenoids or loose or corroded connections. 2. Pump motor brushes stuck, corroded or worn out. 3. Armature commutator dirty. 4. Armature faulty. 5. Field and frame faulty. 6. Pump gears froze. 7. Power trim pump harness or trim control harness shorted between "Out"/"Up" and "In"/"Down" circuit (pump trying to run in "Out"/"Up" and "In"/"Down" direction simultaneously).	1. Check for battery voltage at terminal "5" (in wiring diagram) while trimming "In"/"Down" and at terminal "3" while trimming "Out"/"Up". If no voltage is indicated, check connections "2", "3", "4" and "5" and/or replace solenoids. 2. Clean or replace, as required. 3. Clean or replace armature, as required. 4. Test for shorted, open or grounded condition and replace if bad. 5. Check for open or grounded condition. Replace field and frame assembly, if bad. 6. Replace pump valve body and gear assembly. 7. Disconnect blue-white lead from solenoid terminal "8". If pump motor will now run in the "In"/"Down" direction, a short in harness exists. Repair or replace harness, as necessary.
Power Trim Pump Motor Runs In The "Out"/"Up" Direction, But Not In The "In"/"Down" Direction -- **"In"/"Down" Solenoid Does Not Click**	1. Loose or dirty solenoid connections. 2. Open "In"/"Down" circuit in trim control or pump wiring harness. 3. Solenoid faulty.	1. Check connections "6" and "7" (in wiring diagram) and clean and/or tighten, as required. 2. Check for battery voltage at terminal "6" while trimming "In"/"Down". If no voltage is indicated, check for a loose or corroded "In"/"Down" circuit connection, damaged "In"/"Down" circuit lead or a faulty "In"/"Down" trim switch. Repair or replace, as required. 3. Replace solenoid.

PROBLEM	POSSIBLE CAUSES	REMEDY
Power Trim Pump Motor Runs In The "Out"/"Up" Direction But Not In The "In"/"Down" Direction -- **"In"/"Down" Solenoid Clicks**	1. Loose or dirty solenoid connection. 2. Faulty solenoid. 3. Faulty "In"/"Down" field winding.	1. Check connections "4" and "5" (in wiring diagram). Clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "5" while trimming "In"/"Down". If no voltage is indicated, replace solenoid. 3. Replace field and frame assembly.
Power Trim Pump Motor Runs In "In"/"Down" Direction But Not "Out"/"Up" Direction (Both Trim and Trailer Switches Inoperative) - **"Out"/"Up" Solenoid Does Not Click**	1. Loose or dirty solenoid connections. 2. Open "Out"/"Up" circuit in trim control or pump wiring harness. 3. Solenoid faulty.	1. Check connections "8" and "9" (in wiring diagram). Clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "8" while trimming "Out"/"Up". If no voltage is indicated, check for a loose or corroded "Out"/"Up" circuit connection, blown fuse (if trim control is so equipped), damaged "Out"/"Up" circuit lead, or a faulty "Out"/"Up" trim switch. Repair or replace, as necessary. 3. Replace solenoid.
Power Trim Pump Motor Runs In "In"/"Down" Direction, But Not "Out"/"Up" Direction (Both Trim and Trailer Switches Inoperative) - **"Out"/"Up" Solenoid Clicks**	1. Loose or dirty solenoid connection. 2. Faulty solenoid. 3. Faulty "Out"/"Up" field winding.	1. Check connections "2" and "3" (in wiring diagram) and clean and/or tighten, as necessary. 2. Check for battery voltage at terminal "3" while trimming "Out"/"Up". If no voltage is indicated, replace solenoid. 3. Replace field and frame assembly.
Trim Control "Out"/"Up" Trim Switch Inoperative - **Trailer Switch Operates**	1. Trim limit switch lead bullet connectors loose or corroded. 2. Trim limit switch or leads faulty. 3. Open in trim control "Out"/"Up" circuit.	1. Clean and/or tighten connections "14", "15", "16" and "17" (in wiring diagram), as necessary. 2. Disconnect trim limit switch leads from trim harness. Connect a continuity meter between leads "16" and "17". Continuity should be indicated with drive unit in full "In"/"Down" position. If not, check for damaged leads or poor connections. If this is not the cause, replace limit switch. 3. Check for a loose or corroded "Out"/"Up" circuit connection, damaged "Out"/"Up" circuit lead or faulty "Out"/"Up" trim switch. Repair or replace, as necessary.
Trim Control Trailer Switch Inoperative -- **Trim "Out"/"Up" Switch Functions**	1. Open in trim control trailer circuit.	1. Check for a faulty trailer switch, loose or corroded connections or damaged trailer circuit lead.
Trim System Functions While Unattended	1. Faulty trim or trailer switch. 2. Shorted trim pump harness or trim control harness.	1. Replace switch. 2. Repair or replace, as required.


BLACK
GREEN-WHITE
BLUE-WHITE
RED-PURPLE
DOWN TRIM SOLENOID
90 AMP FUSE
UP TRIM SOLENOID
20 AMP
HYDRAULIC PUMP MOTOR
POWER TRIM
12 VOLT BATTERY
RED
TRIM LIMIT SWITCH
BLUE SLEEVE
PURPLE SLEEVE
PURPLE-WHITE
PURPLE
WHITE
BLUE
SHIFT THROTTLE CONTROL
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

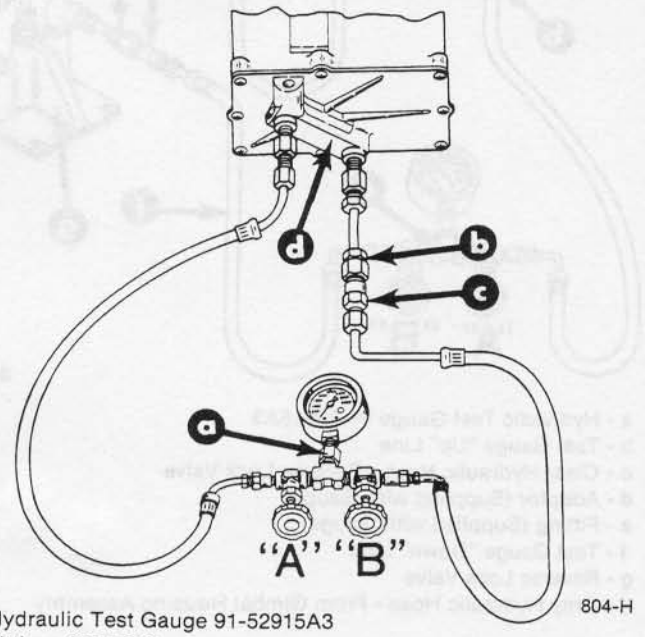
Troubleshooting Power Trim Hydraulic System

PROBLEM	POSSIBLE CAUSES	REMEDY
Drive Unit Cannot Be Trimmed "Out"/"Up" Or Trims Slowly Or with Jerky Movements	1. Power trim pump oil level low. 2. Air in trim system. 3. Insufficient pump pressure or pump shuttle valve stuck. 4. Hoses reversed on one cylinder only. 5. Trim cylinder(s) binding. 6. Gimbal housing-to-trim pump hydraulic hoses pinched.	1. Check for cause of low oil level and correct. Add oil. 2. Check for cause of entry and correct. Add oil to pump and bleed trim system. 3. Test, as explained following. Replace valve body and gear assembly. 4. Connect hoses correctly. 5. Check for cause of binding (bent piston rod, etc.). Repair or replace, as necessary. 6. Replace hose.
Drive Unit Cannot Be Lowered From "Out"/"Up" Position or Lowers with Jerky Movements	1. Air in trim system. 2. Insufficient pump "In"/"Down" pressure or shuttle valve stuck. 3. Trim cylinder(s) leaking internally. 4. Trim cylinder(s) binding. 5. Gimbal housing-to-trim pump hydraulic hose pinched. 6. Hoses reversed on one trim cylinder only. 7. Drive unit binding in gimbal ring.	1. Check for cause of entry. Fill and bleed trim system. 2. Test, as explained following. Replace valve body and gear assembly. 3. Test, as explained following. Rebuild or replace cylinder, as necessary. 4. Check for cause of binding (bent piston rod, etc.). Repair or replace, as necessary. 5. Replace hose. 6. Reconnect hoses correctly. 7. Check for cause of binding (bent gimbal ring, drive shaft housing, etc.) and replace.
Drive Unit Will Not Stay In Full "Out"/"Up" Position For Extended Periods	1. External leakage. 2. Pump "Out"/"Up" circuit leaking internally.	1. Check for cause and correct. Add oil to pump and bleed trim system. 2. Test, as explained following. Replace valve body and gear assembly. Also check trim cylinders for internal leakage.
Drive Unit Will Not Stay In Trimmed "Out"/"Up" Position When Underway	1. Air in trim system. 2. External leakage. 3. Pump "Out"/"Up" circuit leaking internally.	1. Check for cause of entry. Fill and bleed system. 2. Check for cause and correct. Add oil to pump and bleed trim system. 3. Test as explained following. Replace valve body and gear assembly.
Drive Unit Trails "Out"/"Up" on Deacceleration or When Shifting Into Reverse (Unit Thumps When Shifting)	1. Air in trim system. 2. Trim cylinder(s) leaking internally. 3. Trim pump "In"/"Down" circuit leaking internally.	1. Determine cause for air entry and correct. Add oil to pump and bleed trim sytem. 2. Test, as explained following. Replace or rebuild cylinders, as necessary. 3. Test, as explained following.
Oil Foams Out of Pump "Vent" Screw	1. Contaminated oil. 2. Oil level low.	1. Flush system with clean oil, refill pump and bleed trim system. 2. Check for cause of low oil level and correct. Add oil to pump and bleed system.

Testing Power Trim System

Power Trim Pump Test

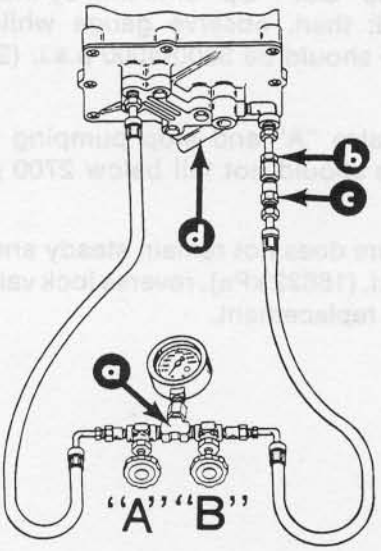
1. Before proceeding -
   - Check trim pump oil level.
   - Check for external leaks.
   - Place drive unit in full "In"/"Down" position.
2. Connect test gauge at most convenient location.



804-H

a - Hydraulic Test Gauge 91-52915A3
b - Fittings 22-77366

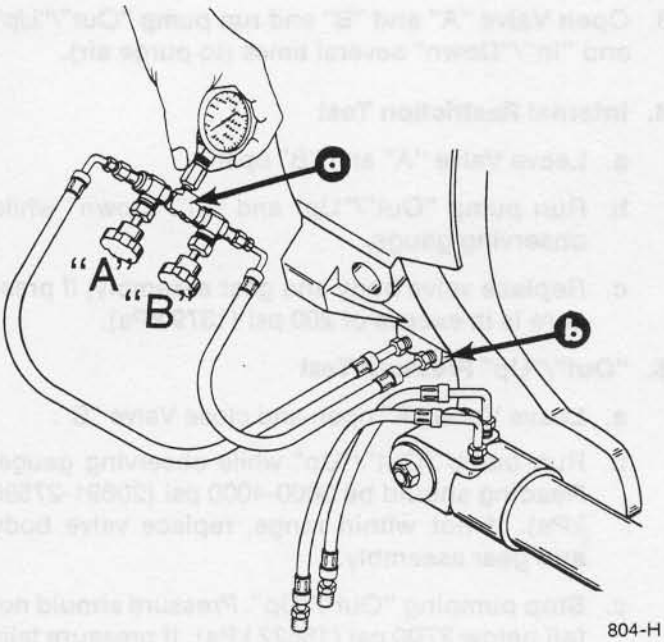
Pump WITHOUT External Control Valve Shown



804-H

a - Hydraulic Test Gauge 91-52915A3
b - Adaptor — From 91-52915A3
c - Fitting — From 91-52915A3
d - Control Valve

Pumps WITH External Control Valve Gauge Connected at Pump



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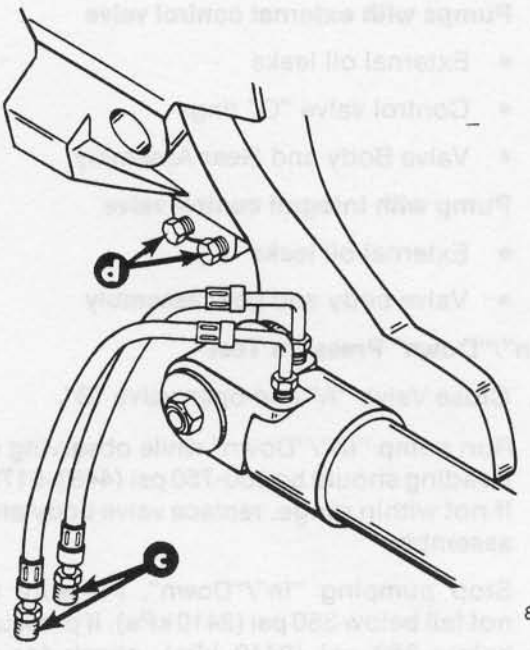


804-H

a - Test Gauge 91-52915A3
b - Gimbal Housing Hydraulic Connector
c - Caps — Supplied with Gauge
d - Plugs — Supplied with Gauge

Gauge Connected at Housing Hydraulic Connector

3. Open Valve "A" and "B" and run pump "Out"/"Up" and "In"/"Down" several times (to purge air).

4. **Internal Restriction Test**

   a. Leave Valve "A" and "B" open.

   b. Run pump "Out"/"Up" and "In"/"Down" while observing gauge.

   c. Replace valve body and gear assembly, if pressure is in excess of 200 psi (1379 kPa).

5. **"Out"/"Up" Pressure Test**

   a. Leave Valve "A" open and close Valve "B".

   b. Run pump "Out"/"Up" while observing gauge. Reading should be 3000-4000 psi (20691-27588 kPa). If not within range, replace valve body and gear assembly.

   c. Stop pumping "Out"/"Up". Pressure should not fall below 2700 psi (18622 kPa). If pressure falls below 2700 psi (18622 kPa), check for and/or replace following:

   Pumps with external control valve

   - External oil leaks
   - Control valve "O" rings
   - Valve Body and Gear Assembly

   Pump with integral control valve

   - External oil leaks
   - Valve body and gear assembly

6. **"In"/"Down" Pressure Test**

   a. Close Valve "A" and open valve "B".

   b. Run pump "In"/"Down" while observing gauge. Reading should be 650-750 psi (4483-5173 kPa). If not within range, replace valve body and gear assembly.

   c. Stop pumping "In"/"Down". Pressure should not fall below 350 psi (2410 kPa). If pressure falls below 350 psi (2410 kPa), check for and/or replace following:

   Pumps with external control valve

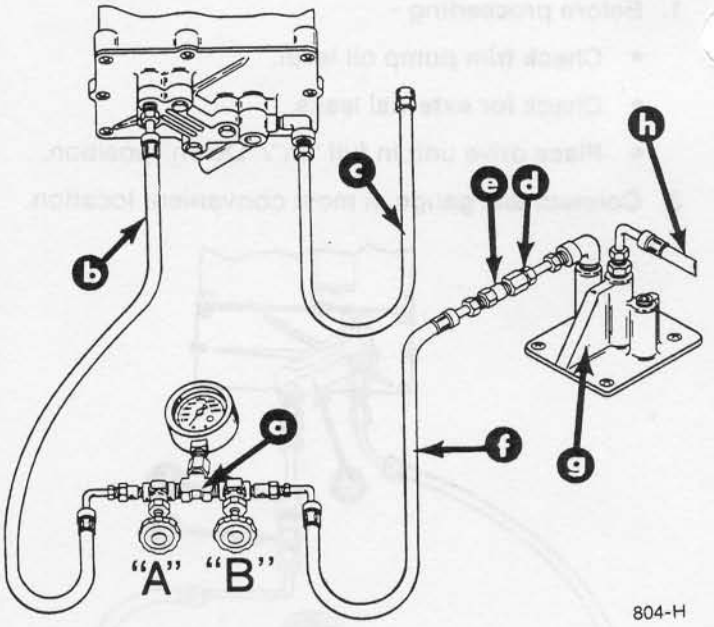
   - External oil leaks
   - Control valve "O" rings
   - Valve body and gear assembly

   Pumps with integral control valve

   - External oil leaks
   - Valve body and gear assembly

Reverse Lock Valve Test

1. Connect test gauge, as shown.



804-H

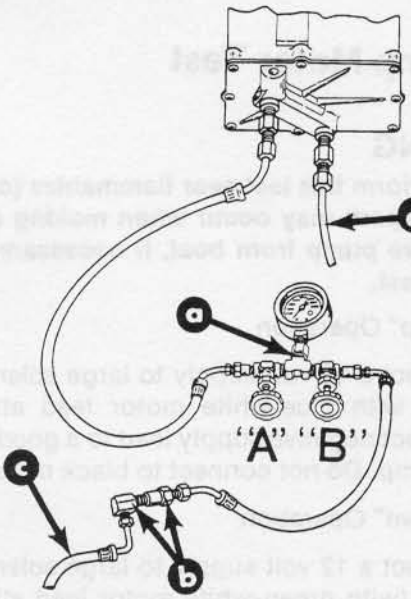
a - Hydraulic Test Gauge 91-52915A3
b - Test Gauge "Up" Line
c - Clear Hydraulic Hose - Reverse Lock Valve
d - Adaptor (Supplied with Gauge)
e - Fitting (Supplied with Gauge)
f - Test Gauge "Down" Line
g - Reverse Lock Valve
h - Gray Hydraulic Hose - From Gimbal Housing Assembly

2. Open Valve "A" and "B" and run pump "Out"/"Up" and "In"/"Down" several times (to purge air).
3. Run pump "Out"/"Up" until trim cylinders are fully extended; then, observe gauge while pumping. Pressure should be 3000-4000 p.s.i. (20691-27585 kPa).
4. Close Valve "A" and stop pumping "Out"/"Up". Pressure should not fall below 2700 p.s.i. (18622 kPa).
5. If pressure does not remain steady and falls below 2700 p.s.i. (18622 kPa), reverse lock valve assembly requires replacement.

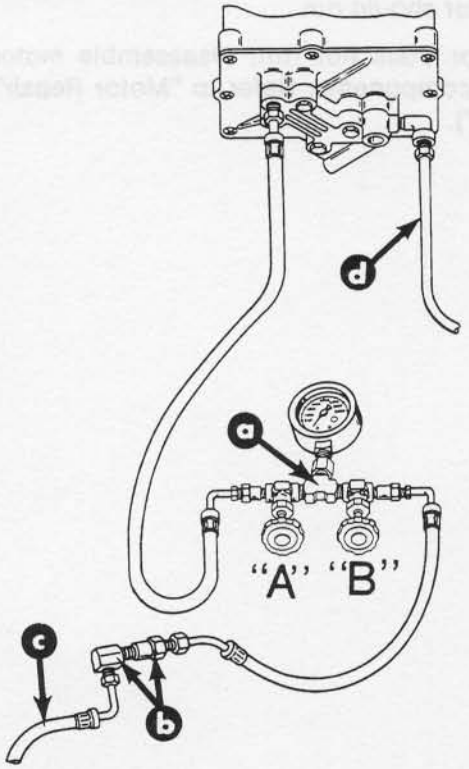
Trim Cylinder Internal Leak Test

IMPORTANT: The following test assumes that pump "Out"/"Up" pressure is within specifications as determined by performing "Power Trim Pump Test".

1. Connect gauge at most convenient location.



Pumps WITHOUT External Control Valve



804-H

a - Hydraulic Test Gauge 91-52915A3
b - Fittings (Supplied with Gauge)
c - Black ("Up") Hydraulic Hose - From Gimbal Housing
d - Clear Plastic ("Down") Hydraulic Hose - To Reverse Lock

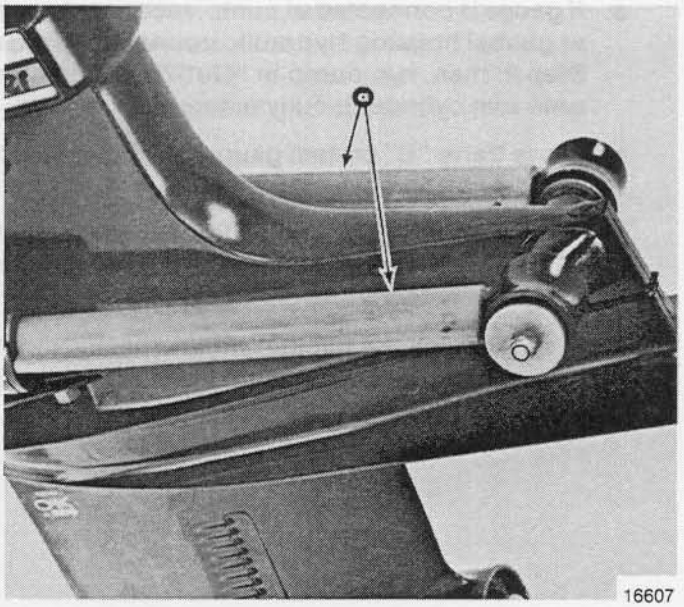
Gauge Connected at Pump

2. Open valve "A" and "B" and run pump "Out"/"Up" and "In"/"Down" several times (t purge air).
3. Run pump "Out"/"Up" until trim cylinders are fully extended: then, observe gauge while pumping. Pressure should be 3000-4000 psi (20691-27588 kPa).
4. Stop pumping "Out"/"Up". Pressure should not fall below 2700 psi (18622 kPa).
5. If readings are not within specifications, an internal trim cylinder leak is indicated. Use the following procedure to locate faulty cylinder.
   a. If gauge is connected at pump, reconnect gauge at gimbal housing hydraulic connector. Repeat Step 2; then, run pump in "Out"/"Up" direction until trim cylinder is fully extended.
   b. Close Valve "B" on test gauge and repeat Steps 3 and 4.
      - If readings are not within specifications, trim cylinder on same side of drive unit as gauge is faulty.
      - If readings are still not within specifications, trim cylinder on opposite side of drive unit as gauge is faulty.

Trim Cylinder Shock Piston Test

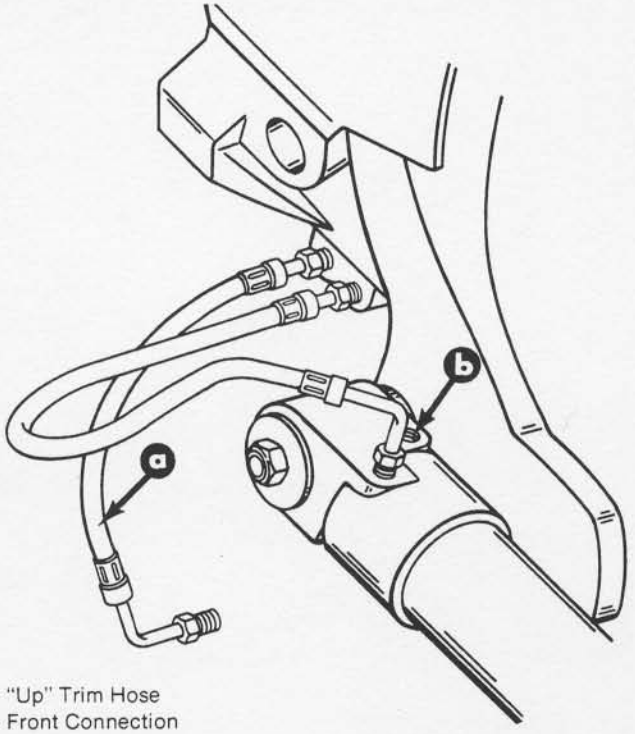
If trim system checks out good, but drive unit will not trim "In"/"Down", problem may be due to a leaky trim cylinder shock piston. Use the following test to check for this condition. Test gauge is not required.

1. Run pump in "Out"/"Up" direction until trim cylinders are fully extended.
2. Prevent trim cylinder piston rods from retracting, using a suitable device. Quicksilver Trailering Kit 41155A1 works well for this purpose.



a - Trailering Kit 41155A1

3. Disconnect "Up" trim hose from trim cylinders.



a - "Up" Trim Hose
b - Front Connection

4. Run pump in "In"/"Down" direction. If oil flows from "Up" port on trim cylinder, shock piston is leaking and must be replaced.

Motor and Electrical Bench Test

Trim Pump Motor Test

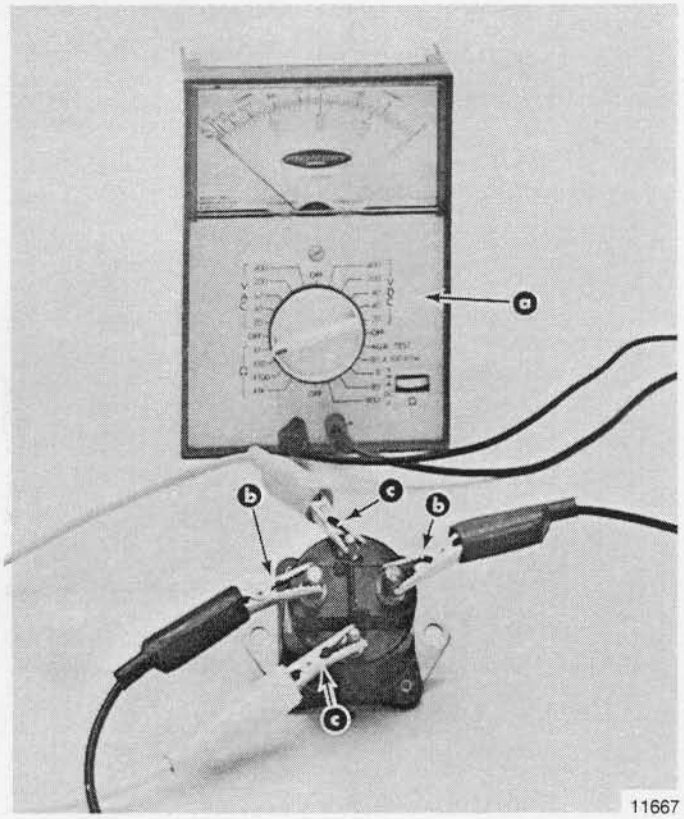
⚠WARNING

DO NOT perform this test near flammables (or explosives), as a spark may occur when making connections. Remove pump from boat, if necessary, before performing test.

1. "Out"/"Up" Operation
   - Connect a 12 volt supply to large solenoid terminal with blue-white motor lead attached). Connect negative supply lead to a good ground on pump. Do not connect to black motor lead.
2. "In"/"Down" Operation
   - Connect a 12 volt supply to large solenoid terminal (with green-white motor lead attached). Connect negative supply lead to a good ground on pump. Do not connect to black motor lead.
   - Motor should run.
3. If motor does not run, disassemble motor and check components. Refer to "Motor Repair" (see "Index").

Solenoid Test

1. Disconnect all wires from solenoid.
2. Check solenoid for full continuity, using ohmmeter and 12-volt supply. Solenoid should click - meter should read approximately zero ohms.



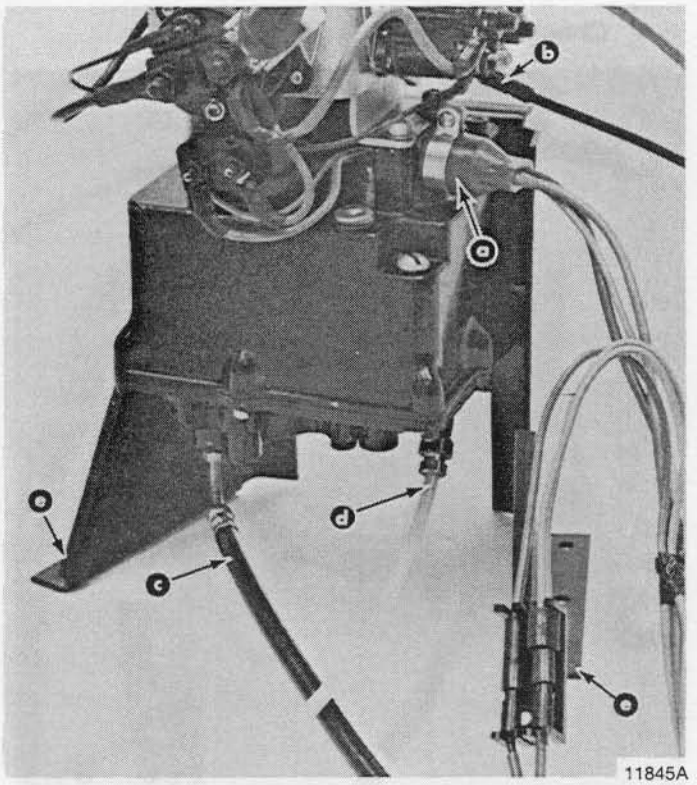
a - Ohmmeter - Rx1 Scale
b - Ohmmeter Leads
c - 12-Volt Supply (Leads)

3. **Zero ohms read (full continuity) -** solenoid OK.
   High ohm reading (no continuity) - replace solenoid.

Trim Pump Removal and Installation

Removing Trim Pump From Boat

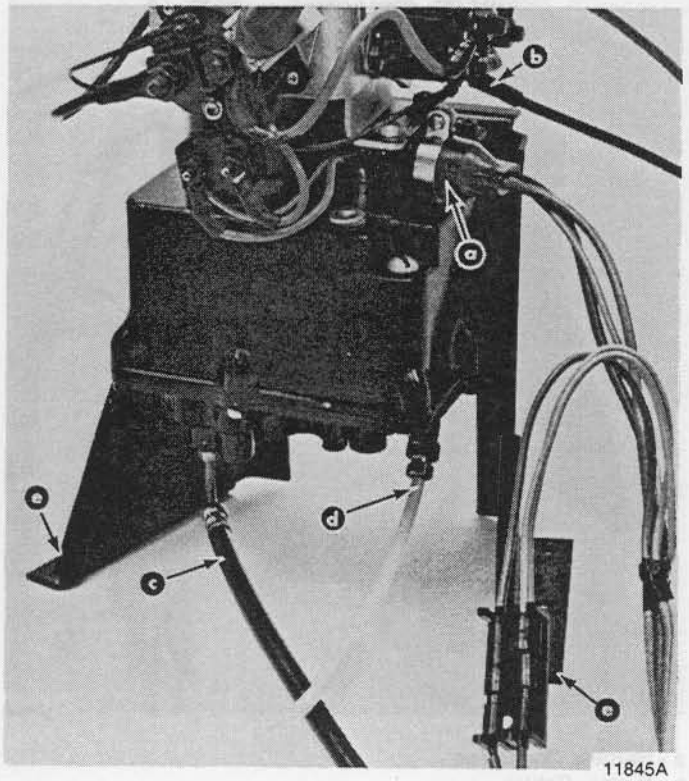
1. • Disconnect trim pump battery cables from battery (negative lead first).
   • Disconnect trim harness from trim pump.
   • Remove hydraulic hoses from pump. Cap end of hoses; plug ports in pump.
   • Remove lag bolts and washers, and lift pump and mounting bracket from boat.



a - Harness Connector
b - Battery Cables
c - Black Hydraulic Hose - From Gimbal Housing
d - Clear Hydraulic Hose - From Reverse Lock Valve
e - Lag Bolts and Washers

Installing Trim Pump

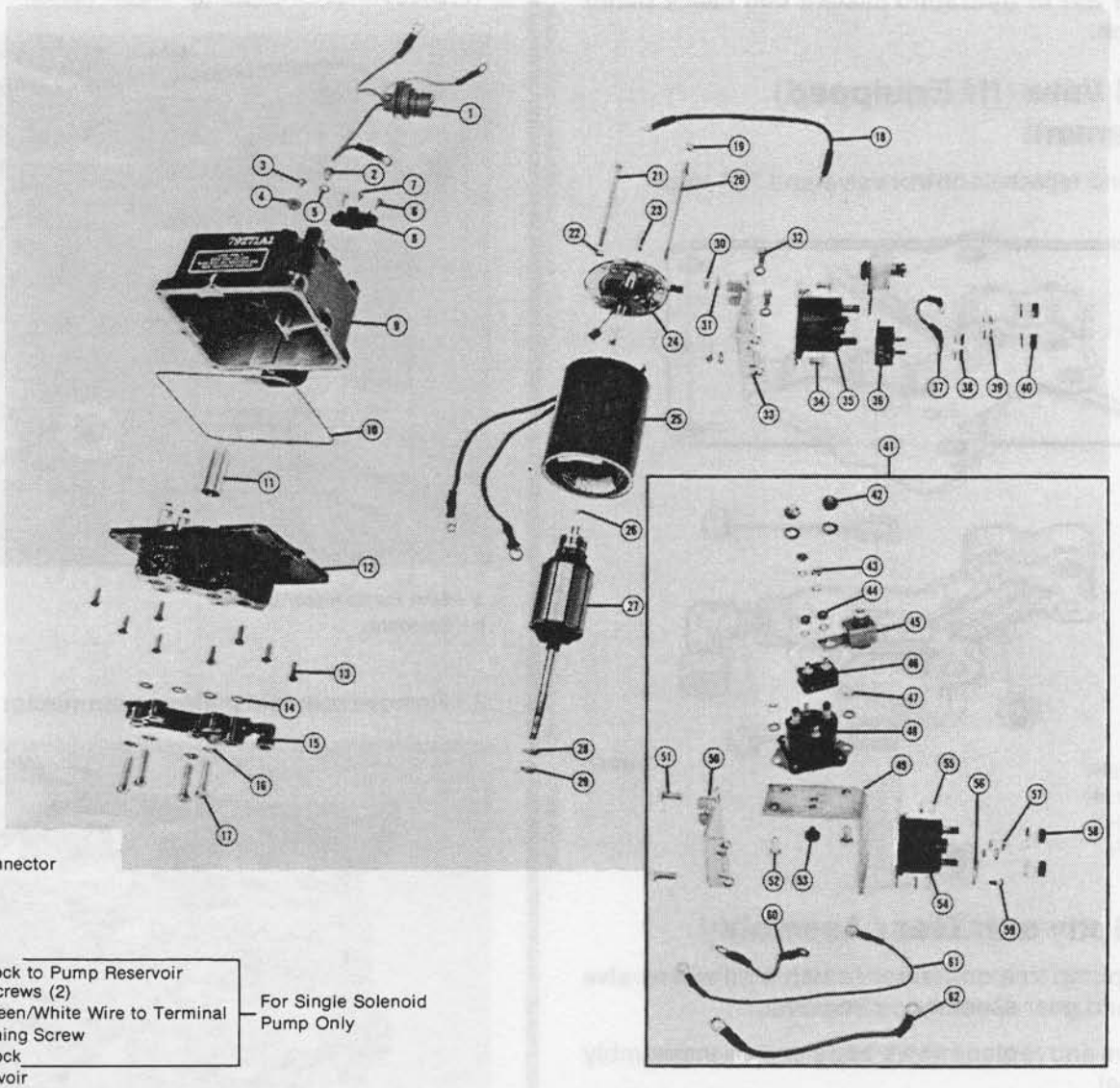
1. • Secure pump and mounting bracket to boat, using lag bolts and washers.
   - Reconnect trim hoses to pump. Black hose to left connection; clear hose to right connection. DO NOT cross-thread or over-tighten hose fittings.
   - Reconnect trim harness connector to trim pump.
   - Connect battery cables to battery.
   - Check oil level, and fill if necessary. Refer to "Maintaining Power Trim Pump Oil Level", see "Index".
   - Check for oil leaks.



11845A

a - Harness Connector
b - Battery Cables
c - Black Hydraulic Hose - From Gimbal Housing
d - Clear Hydraulic Hose - From Reverse Lock Valve
e - Lag Bolts and Washers

Prestolite High Power Trim Pump - Exploded Parts View



12027

1 - Harness Connector
2 - Fill Screw
3 - Vent Screw
4 - Washer
5 - "O" Ring
6 - Terminal Block to Pump Reservoir Attaching Screws (2)
7 - Green or Green/White Wire to Terminal Block Attaching Screw
8 - Terminal Block

(6, 7, 8: For Single Solenoid Pump Only)

9 - Pump Reservoir
10 - "O" Ring
11 - Inlet Cam
12 - Valve Body and Gear Assembly
13 - Valve Body to Reservoir Screw (8)
14 - "O" Rings (4)
15 - Control Valve
16 - Lock Washer (4)
17 - Control Valve to Pump Screw (4)

(14, 15, 16, 17: If Equipped with External Control View)

18 - Pump to Solenoid Black Wire
19 - Solenoid Bracket to Pump Mounting Nut
20 - End Plate and Field Frame Mounting Bolt (Hex Head)
21 - End Plate and Field Frame Mounting Bolt
22 - Lockwasher
23 - Brush Spring (2)
24 - End Plate
25 - Field and Frame Assembly
26 - Ball Bearing
27 - Armature
28 - Fiber Washer
29 - Washer
30 - Solenoid to Bracket Nut (2)
31 - Lockwasher (2)
32 - Bracket to Reservoir Screw and Lockwasher (2)
33 - Solenoid Bracket
34 - Solenoid to Bracket Bolt (2)
35 - Solenoid
36 - 20 Amp Circuit Breaker
37 - Large Solenoid Terminal to Circuit Breaker Red Wire
38 - Wire to Circuit Breaker Attaching Nut and Lockwasher (2)
39 - Wire to Solenoid Small Terminal Attaching Nut and Lockwasher (2)
40 - Fuse or Wire to Solenoid Attaching Nut and Lockwasher (2)
41 - For Dual Solenoid Pump
42 - Fuse or Wire to Solenoid Attaching Nut and Lockwasher (2)
43 - Wire to Solenoid (Small) Nut and Lockwasher
44 - Wire to Circuit Breaker Attaching Nut and Lockwasher (2)
45 - Fuse
46 - Circuit Breaker
47 - Solenoid to Bracket Attaching Nut and Lockwasher (2)
48 - Solenoid
49 - "L" Bracket
50 - Solenoid Bracket
51 - Solenoid to Bracket Attaching Bolt (2)
52 - Solenoid to Bracket Attaching Bolt
53 - Rubber Bumper
54 - Solenoid
55 - Solenoid to Bracket Attaching Nut and Lockwasher (2)
56 - Extension Bracket
57 - Wire to Solenoid Small Terminal Attaching Nut and Lockwasher (2)
58 - Wire to Solenoid Large Terminal Attaching Nut and Lockwasher (2)
59 - Green or Green/White Wire to Extension Bracket Attaching Screw
60 - Circuit Breaker to Fuse Red Wire
61 - Solenoid to Solenoid Black Wire
62 - Solenoid to Solenoid Red or Red/Purple Wire

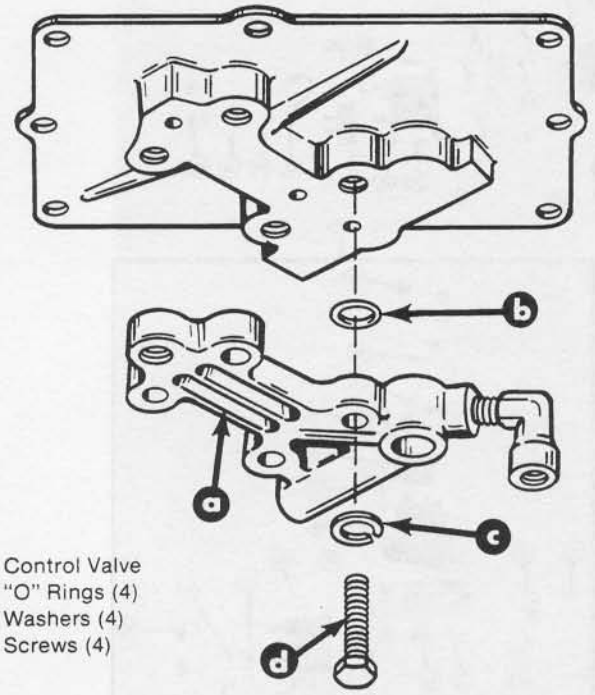
Hydraulic Repair

⚠CAUTION

Work area must be dirt-and-lint free. The slightest amount of dirt in hydraulic system can cause pump malfunction.

Control Valve (If Equipped) Replacement

Remove and replace control valve and "O" rings.

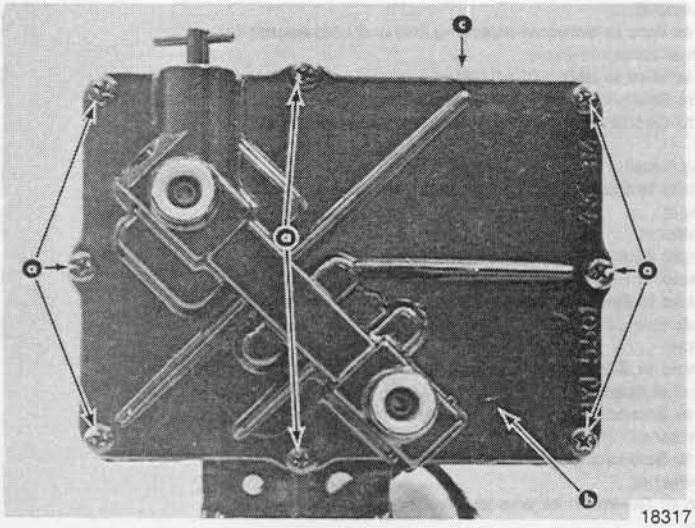


804-H

a - Control Valve
b - "O" Rings (4)
c - Washers (4)
d - Screws (4)

Valve Body and Gear Assembly

1. Place pump in a container to catch oil when valve body and gear assembly is removed.
2. Remove and replace valve body and gear assembly and seal.



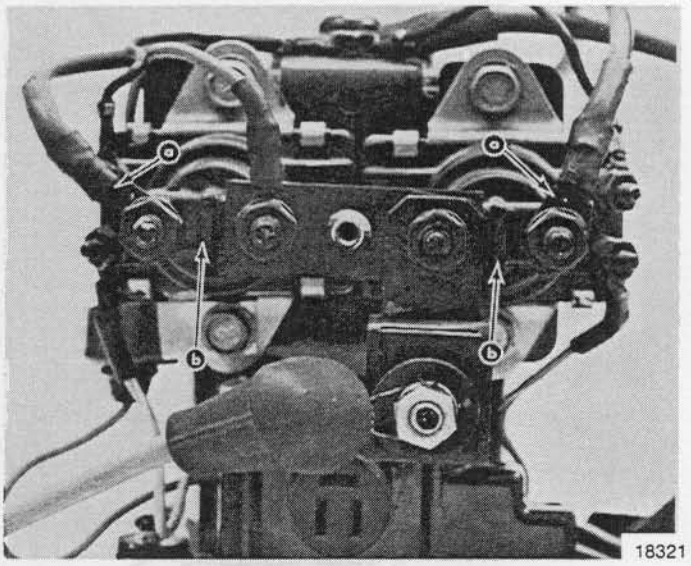
18317

a - Screws (8)
b - Valve Body and Gear Assembly
c - Seal (Not Seen) - Replace

Motor Repair

Removal and Disassembly

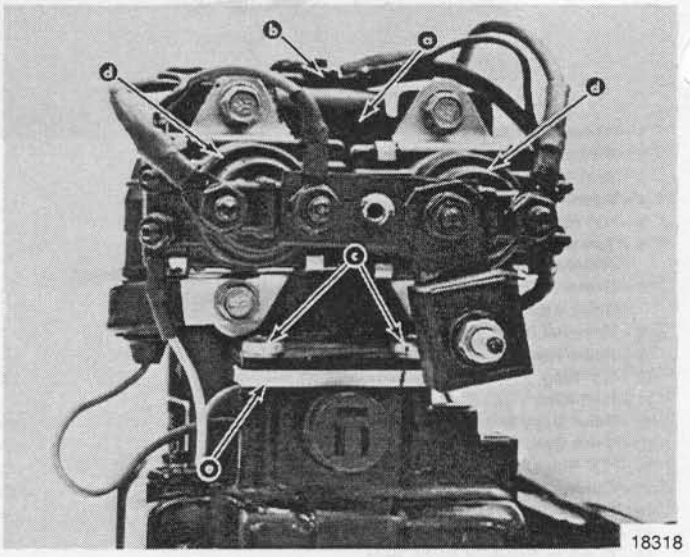
1. Disconnect trim pump motor leads.



18321

a - Trim Pump Motor Leads
b - Solenoids

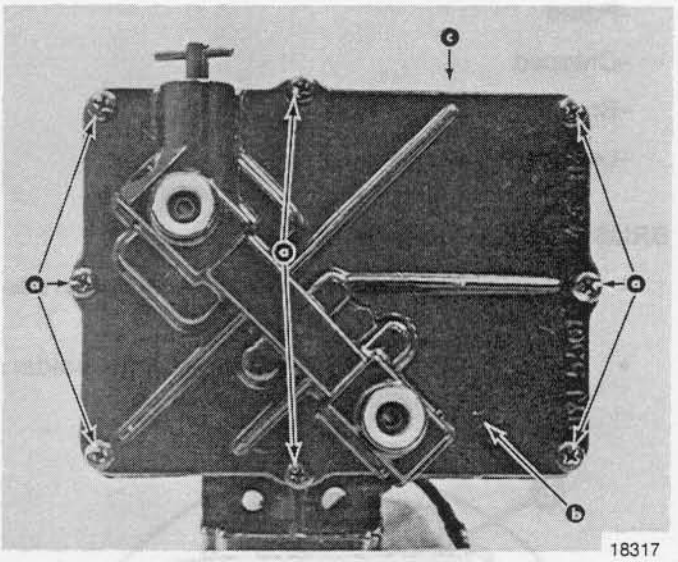
2. Remove solenoid plate and connector and harness.



18318

a - Solenoid Plate
b - Nut
c - Screws
d - Solenoids
e - Connector and Harness

3. Remove valve body and gear assembly.

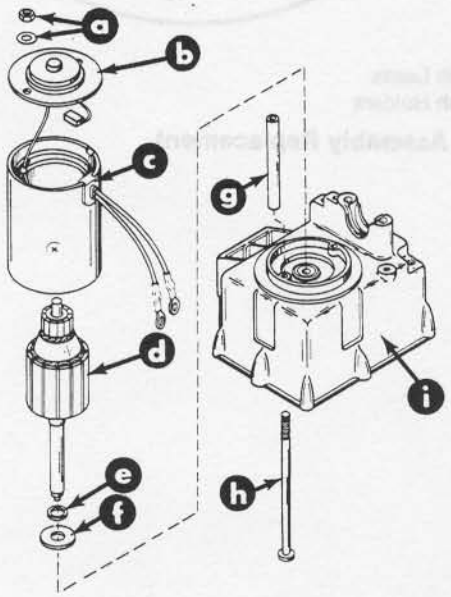


a - Screws (8)
b - Valve Body and Gear Assembly
c - Seal (Not Seen)

NOTE: **Metal Reservoir Pumps:** Pump motor is secured to reservoir by 2 studs inserted thru end cap, field and frame assembly and threaded into reservoir.

Plastic Reservoir Pumps: Pump motor is secured to reservoir by 2 studs inserted thru bottom of reservoir, field and frame assembly and cap and is held in place by nuts and washers.

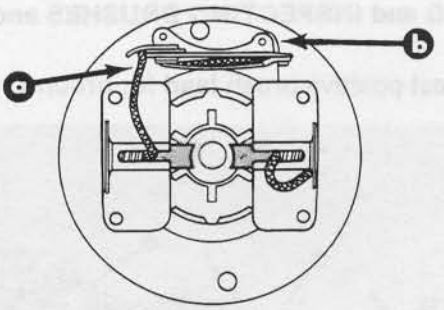
4. Remove motor assembly.



a - Nut and Washer (2) - See "Note" Above
b - End Plate Assembly
c - Field and Frame Assembly
d - Armature
e - Small Thrust Washer(s)
f - Large Thrust Washer
g - Spacer (1)
h - Studs (2) - See "Note" Above
i - Reservoir

Thermal Circuit Breaker Test

1. Test thermal circuit breaker for continuity using ohmmeter set on Rx1 scale.



a - Place Meter Lead at This Point
b - Place Meter Lead at Ground

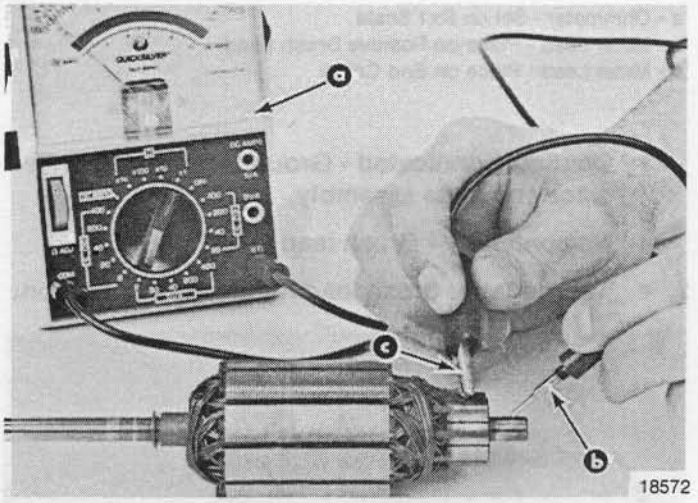
2. **Continuity indicated** - Circuit breaker OK.

   Continuity not indicated - Circuit breaker open; replace end cap.

Armature Tests

TEST for GROUND

1. Check armature for continuity.



a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Armature Shaft
c - Meter Lead - Place on All Commutator Bars (One-at-a-time)

2. **Continuity indicated** - Armature is grounded; replace armature.

   Continuity not indicated - Armature not grounded.

TEST for SHORTS

Check armature on a growler (follow growler manufacturer's test instructions). Indication of short requires armature replacement.

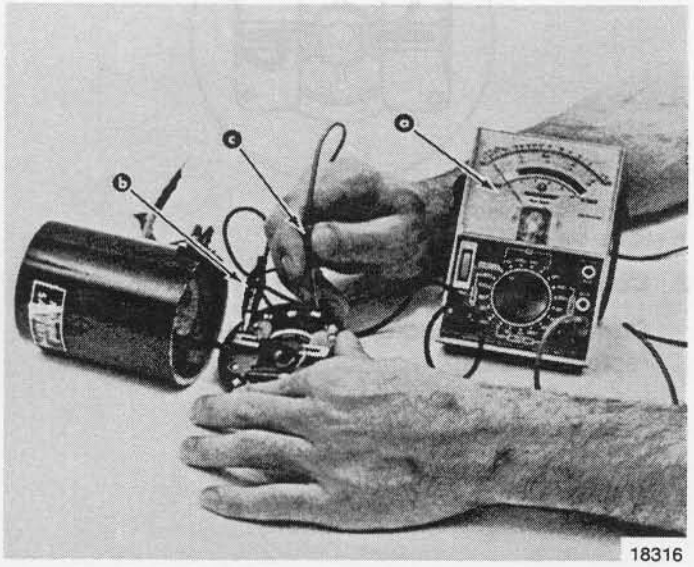
CHECKING and CLEANING COMMUTATOR

1. If commutator is worn, turn down on an armature conditioner tool or lathe.
2. Clean commutator with "OO" garnet grit sandpaper. DO NOT use emery paper.

Brush Lead Testing and Brush and End Cap Replacement

TESTING and INSPECTING BRUSHES and LEADS

1. • Test positive brush lead for ground.

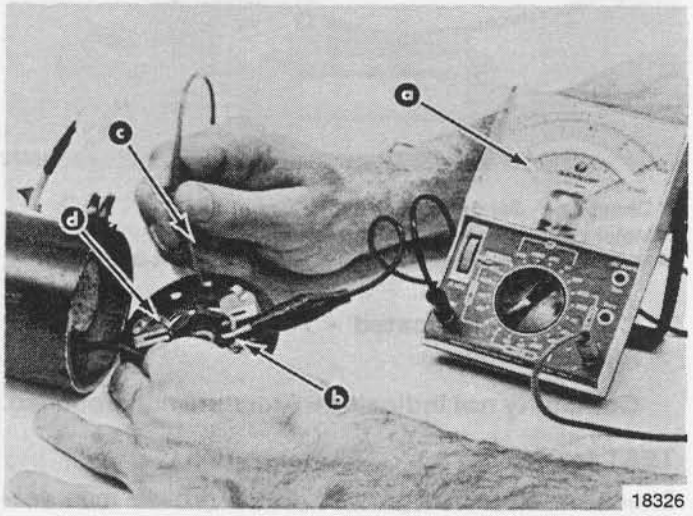


18316

a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Positive Brush Lead
c - Meter Lead - Place on End Cap

- **Continuity indicated** - Grounded condition; Replace end plate assembly.
- **No continuity** - Brush lead OK.

2. • Test negative brush lead for an open condition.



18326

a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Negative Brush Lead
c - Meter Lead - Place on End Cap
d - Positive Brush Lead

- **Continuity indicated** - Brush lead OK.
- **Continuity NOT indicated** - Inspect lead for a poor connection.

3. Inspect brushes and replace if:

   -Pitted

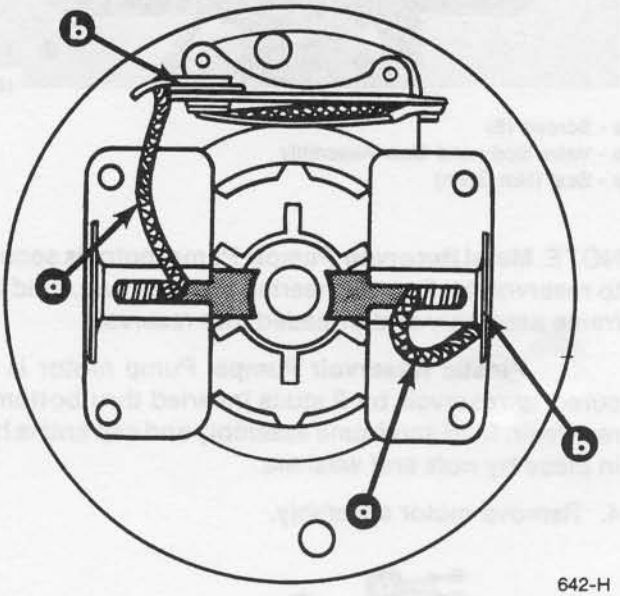
   -Chipped

   -Brush is less than 1/4 in. (6mm) long

   -Leads are fraying

BRUSH REPLACEMENT

- Cut brush leads off as close to brush holders as possible.
- Using 70-30 tin-lead alloy rosin core solder, solder new brushes to brush holders.

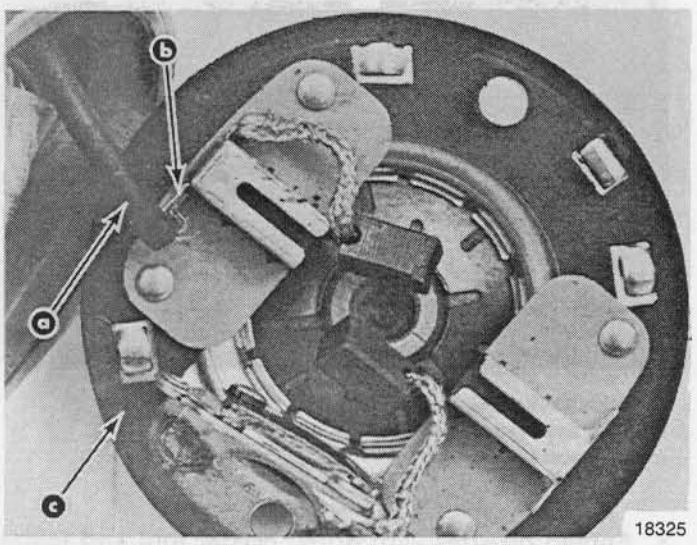


642-H

a - Brush Leads
b - Brush Holders

Brush Assembly Replacement

- Cut off field to positive brush holder lead as close to brush holder as possible.
- Using 70-30 tin-lead alloy rosin core solder, solder field lead to brush holder on new end cap.

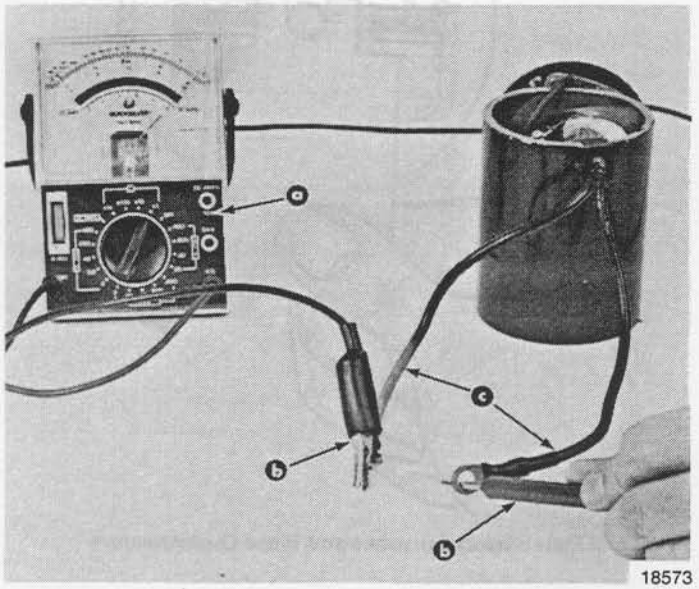


a - Field Lead
b - Positive Brush Holder
c - End Cap

End Cap Replacement

Field Tests

1. • Check field for open condition.

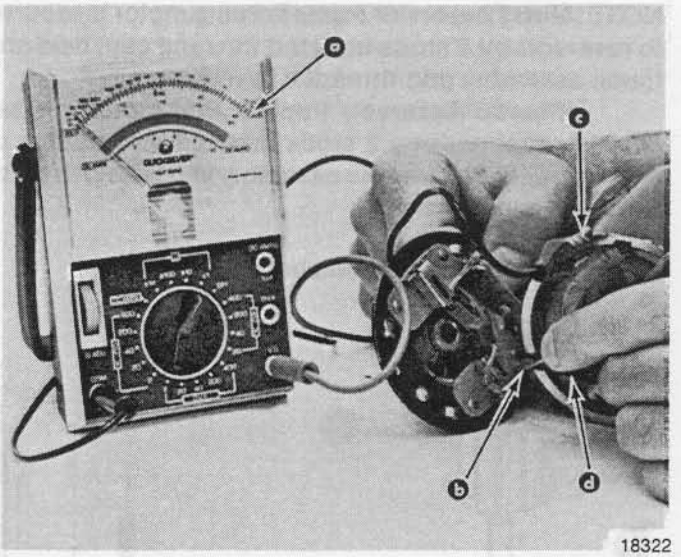


a - Ohmmeter - Set on Rx1 Scale
b - Meter Leads - Connect Between Field Leads
c - Field Leads

Continuity indicated - field OK.

No continuity - field open; replace field and frame assembly.

2. Check field for grounded condition.



a - Ohmmeter - Set on Rx1 Scale
b - Meter Lead - Place on Positive Brush Holder Lead
c - Meter Lead - Place on Frame
d - Field Lead

Continuity indicated - field grounded; replace field and frame assembly.

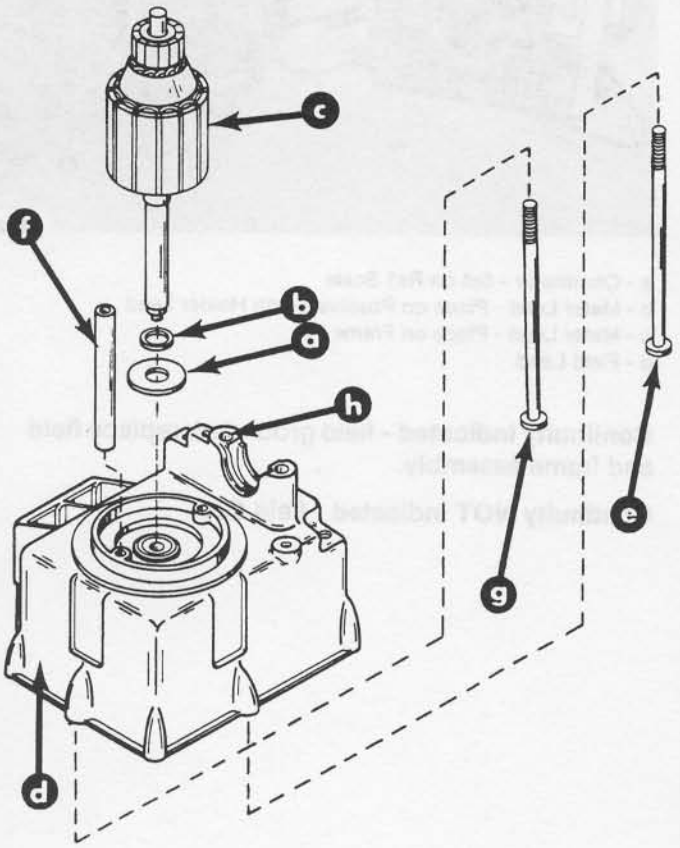
Continuity NOT indicated - field OK.

Reassembly and Installation

NOTE: **Metal Reservoir Pumps:** Pump motor is secured to reservoir by 2 studs inserted thru end cap, field and frame assembly and threaded into reservoir.

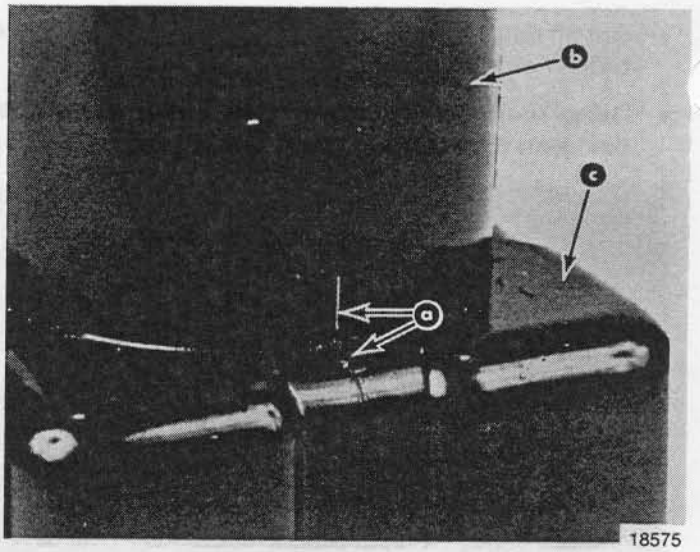
Plastic Reservoir Pumps: Pump motor is secured to reservoir by 2 studs inserted thru bottom of reservoir, field and frame assembly and is held in place by nuts and washers.

1. Install armature and washers.



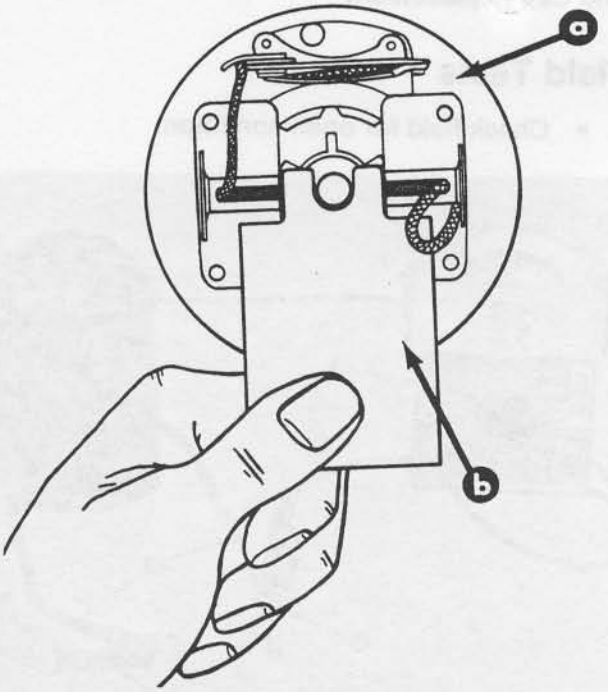
a - Large Washer
b - Small Washer(s)
c - Armature
d - Reservoir
e - Long Stud - See "Note" Above
f - Sleeve (1)
g - Small Stud - See "Note" Above
h - Connector and Holder

2. Install field and frame assembly. Align index mark on field and frame assembly with mark on reservoir.

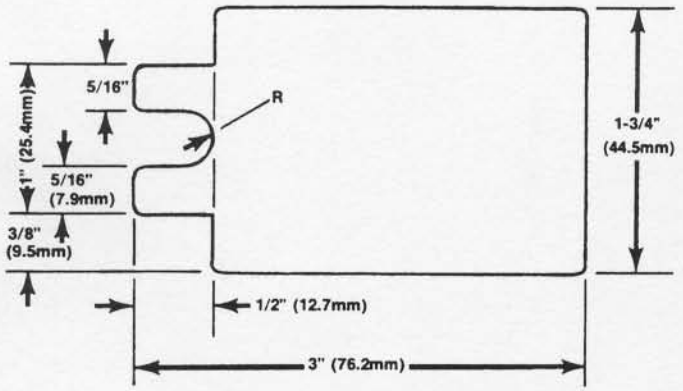


a - Index Marks - Align
b - Field and Frame Assembly
c - Reservoir

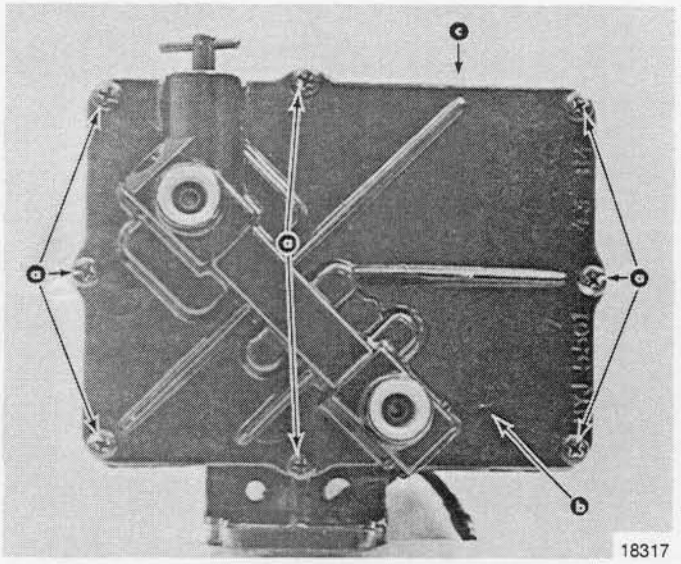
3. Spread brushes with brush holder tool and install end plate over armature. Secure end cap with nuts and washers.



a - End Plate - Spread Brushes and Place Over Armature

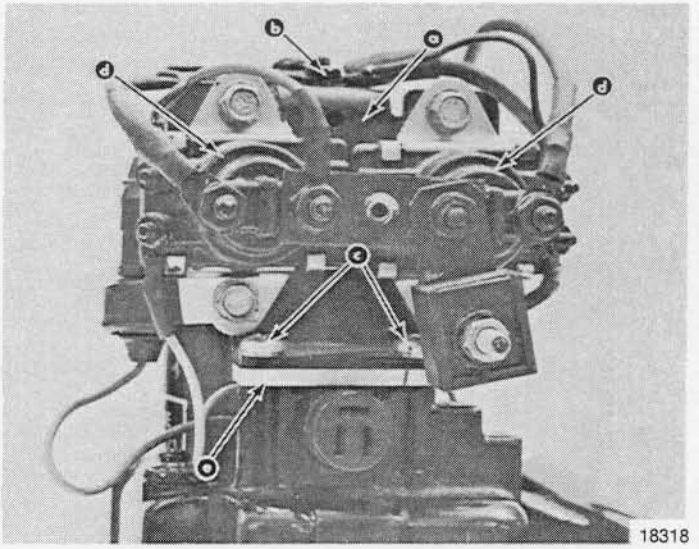


4. Install canister.
5. Install valve body and gear assembly.



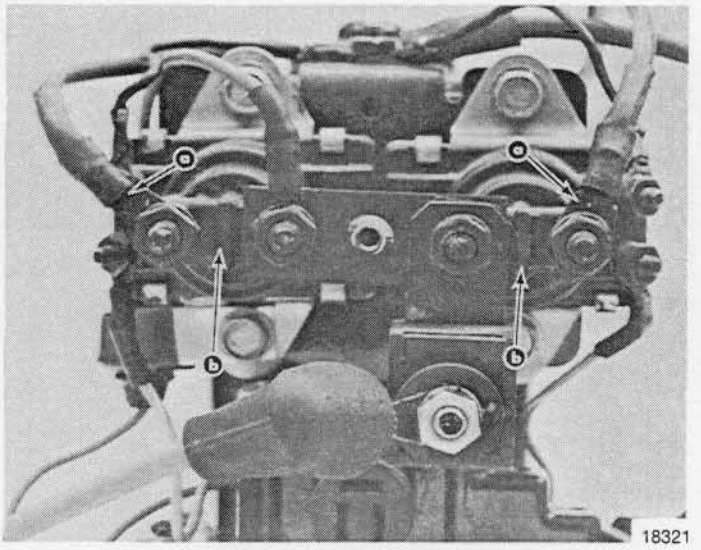
a - Screws (8)
b - Valve Body and Gear Assembly
c - Seal (Not Seen)

6. Install solenoid plate and connector and harness.

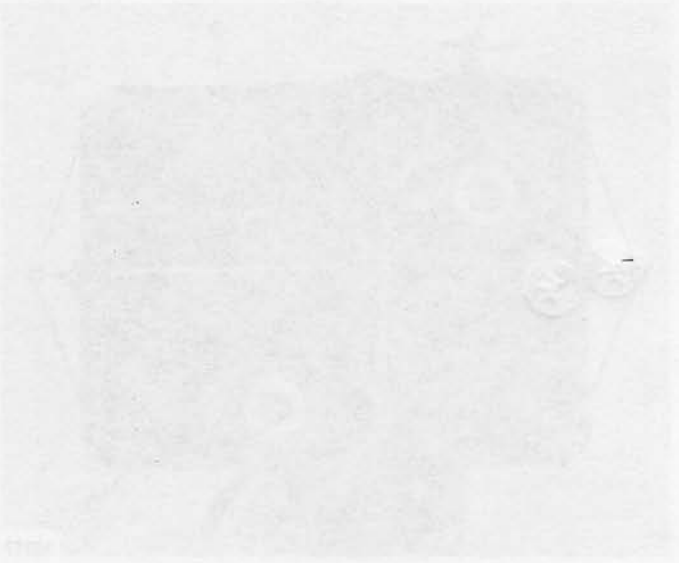


a - Solenoid Plate
b - Nut
c - Screws
d - Solenoids
e - Connector and Harness

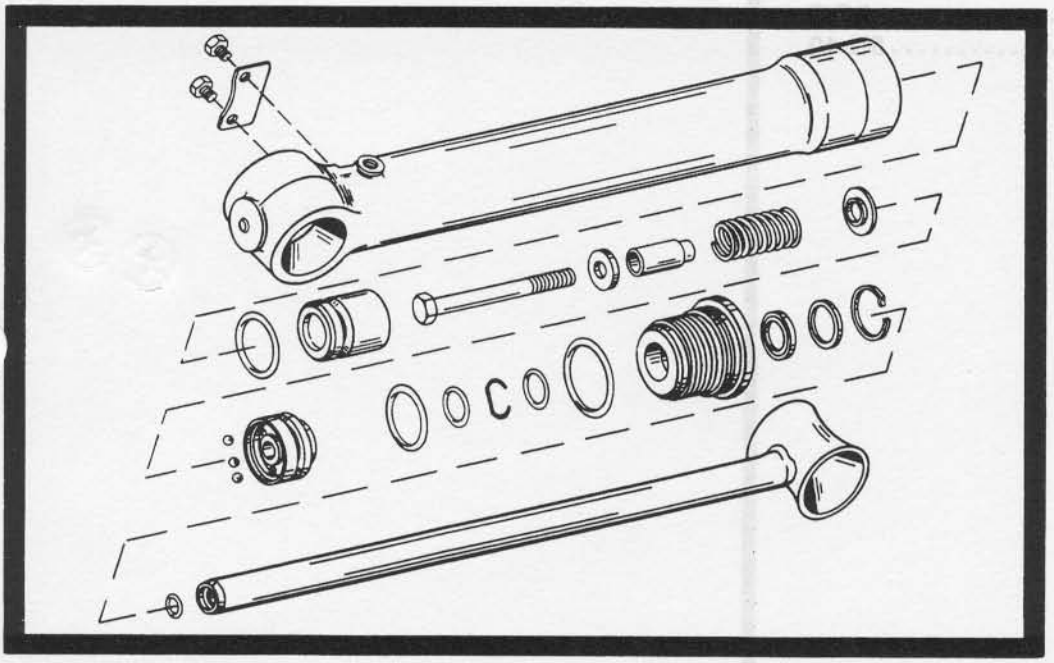
7. Secure trim pump motor leads to solenoids.



a - Blue Lead - Connect to "Out"/"Up" Solenoid
b - Green Lead - Connect to "In"/"Down" Solenoid
c - "Out"/"Up" Solenoid
d - "In"/"Down" Solenoid



POWER TRIM



TRIM CYLINDERS

5

D

mercruiser
STERN DRIVES & INBOARDS

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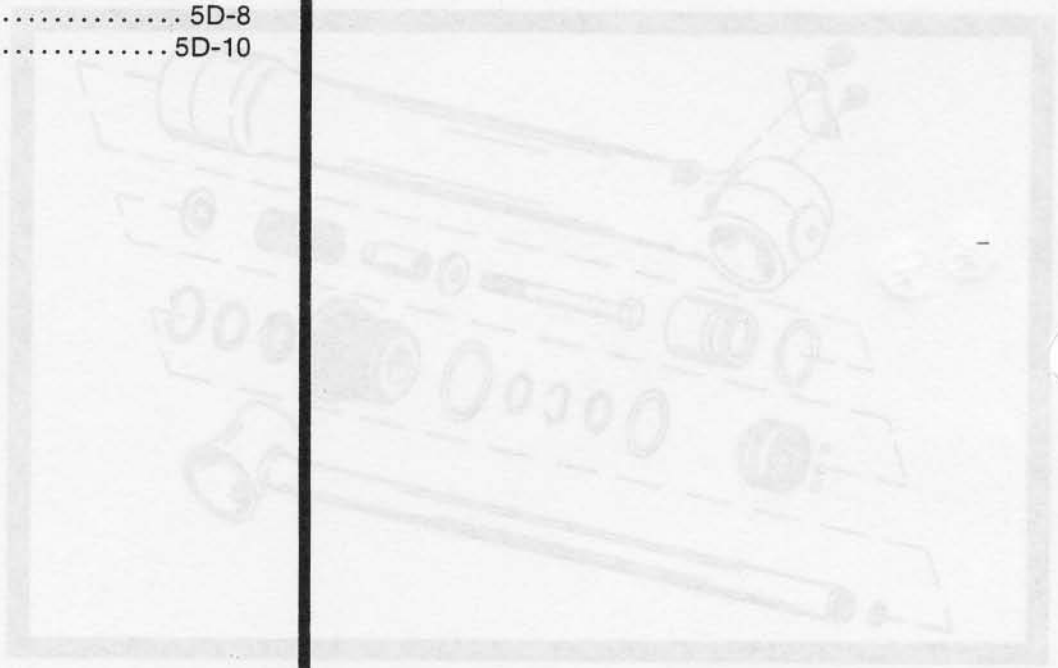


Identification

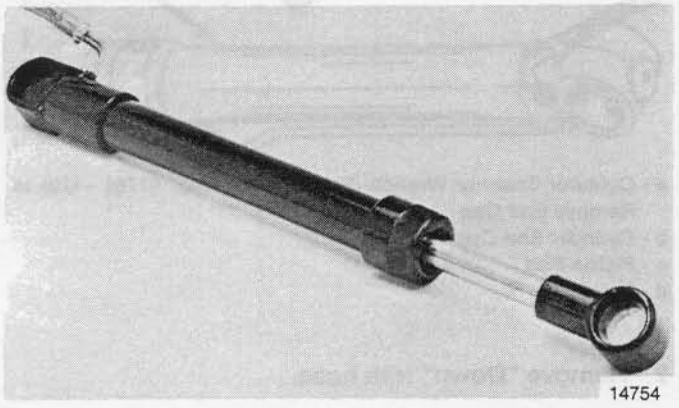
Two types of Power Trim Cylinders are used on MerCruiser TR and TRS Stern Drives -- an external return line cylinder and an internal return line cylinder.

The internal return line trim cylinder (Figure 1) is a high pressure cylinder and is used only on TR/TRS stern drives equipped with the Prestolite "High Pressure" Power Trim Pump. (See Sec. 5-C for "Prestolite High Pressure Power Trim Pump" identification.)

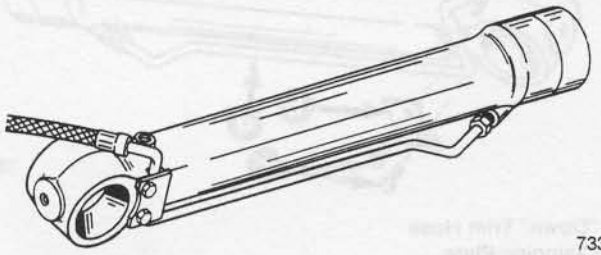
The external return line trim cylinder (Figure 2) is a low pressure cylinder and is used only on TR/TRS stern drives equipped with the Oildyne or Prestolite "Low Pressure" Power Trim Pump. (See Sec. 5-A for "Oildyne Power Trim Pump" identification. See Sec. 5-B for "Prestolite Low Pressure Power Trim Pump" identification.)

⚠CAUTION

Due to differences in internal valving, the internal return line (high pressure) trim cylinder cannot be used to replace an external return line (low pressure) trim cylinder, or vice-versa. Use of incorrect trim cylinders will affect trim operation and may cause damage to trim system.



Internal Return Line "High Pressure" Trim Cylinder



External Return Line "Low Pressure" Trim Cylinder

Torque Specifications

Location	TORQUE	
	External Return Line Cyl.	Internal Return Line Cyl.
Piston Rod Bolt	15-20 Lbs. Ft. (20-27 N.m)	15-20 Lbs. Ft. (20-27 N.m)
Trim Cylinder Anchor Pin Nuts	Tighten until Nuts Bottom on Anchor Pin Shoulder	Tighten until 2 Full Threads of Anchor Pin are Exposed on Nut

Lubricants, Sealers, and Adhesives

Prior to reassembly of trim cylinder(s), lubricate all internal parts with SAE 10W 30 or 10W-40 motor oil.

Description	Part No.
Loctite "A"	92-32609--1
Quicksilver 2-4-C Multi-Lube	92-90018A12
Quicksilver Perfect Seal	92-34227--1

Trim Cylinder Internal Leak Test

Refer to appropriate "Power Trim Pump" section (see "Index").

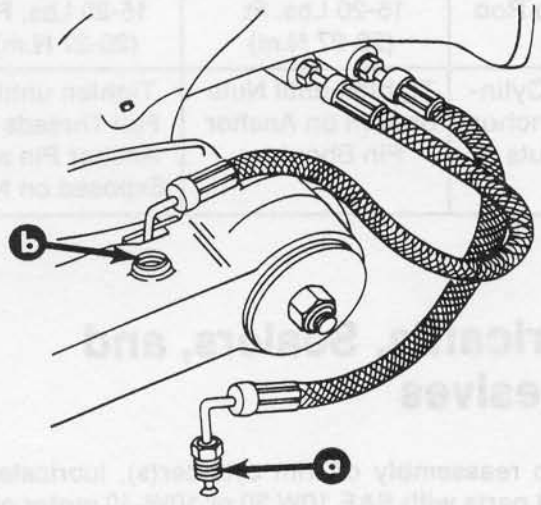
Trim Cylinder Shock Piston Test

Refer to appropriate "Power Trim Pump" section (see "Index").

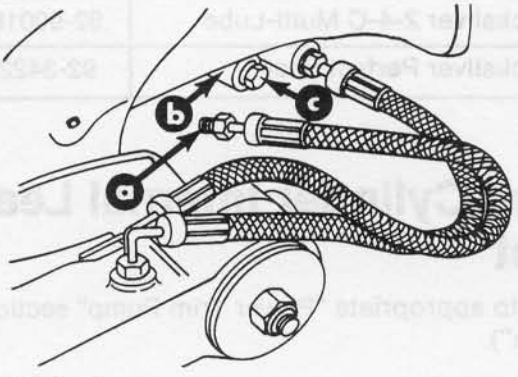
External Return Line Trim Cylinder Repair

REMOVAL

Disconnect "Up" and "Down" trim hoses.

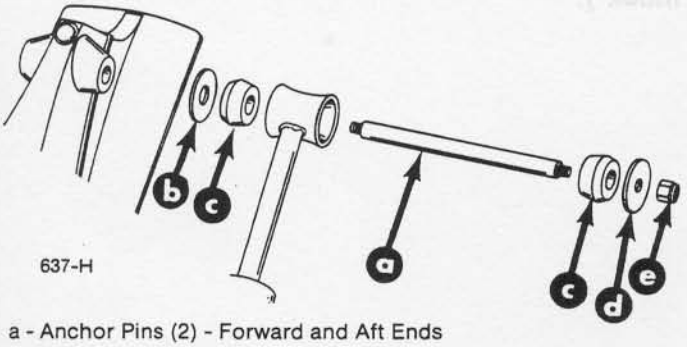


a - "Up" Trim Hose - Cap Hose After Removal
b - Front Port on Trim Cylinder



a - "Down" Trim Hose
b - Hydraulic Connector
c - Plug (22-38609)

2. Remove Power Trim cylinders.



a - Anchor Pins (2) - Forward and Aft Ends
b - Washers - Large ID
c - Bushings
d - Washers - Small ID
e - Nuts

DISASSEMBLY

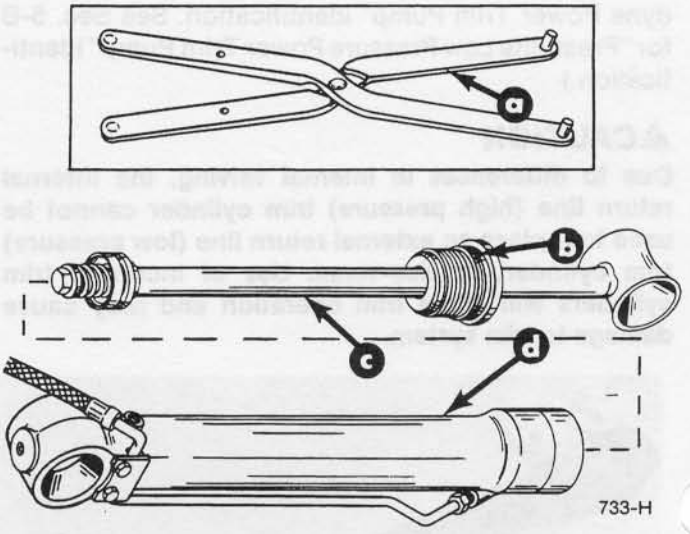
⚠CAUTION

Work in a clean, lint-free area.

NOTE: Spanner Wrench (Snap-On Tool No. A176) for removing and installing end cap may be obtained from:

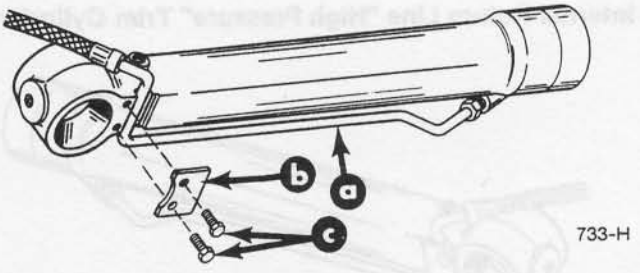
Snap-On Tools
215 S. 162nd St.
New Berlin, WI 53151

- Remove cylinder end cap.
- Pull piston rod from tube.



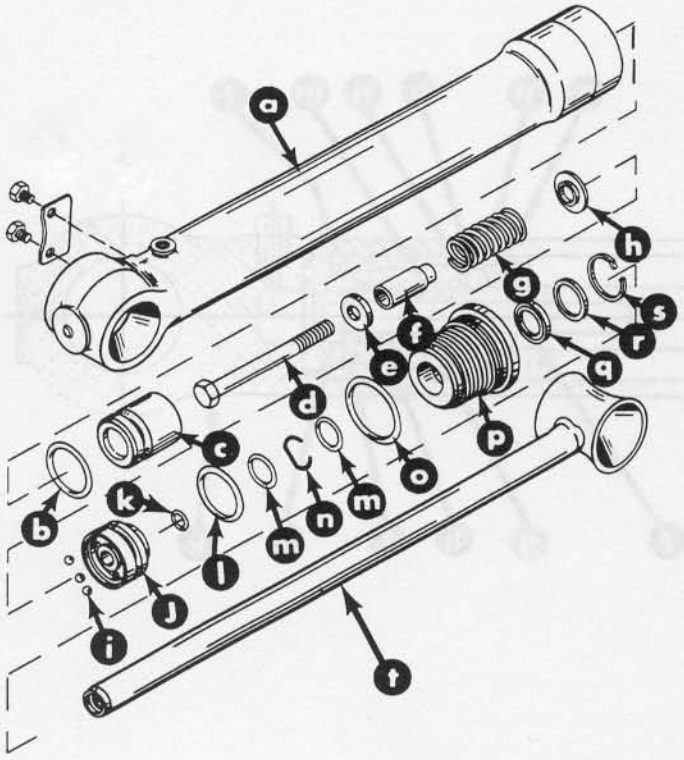
a - Cylinder Spanner Wrench (Snap on Tool No. A176) - Use to Remove End Cap
b - Cylinder End Cap
c - Piston Rod
d - Tube

2. Remove "Down" trim hose.



a - "Down" Trim Hose
b - Clamping Plate
c - Screws

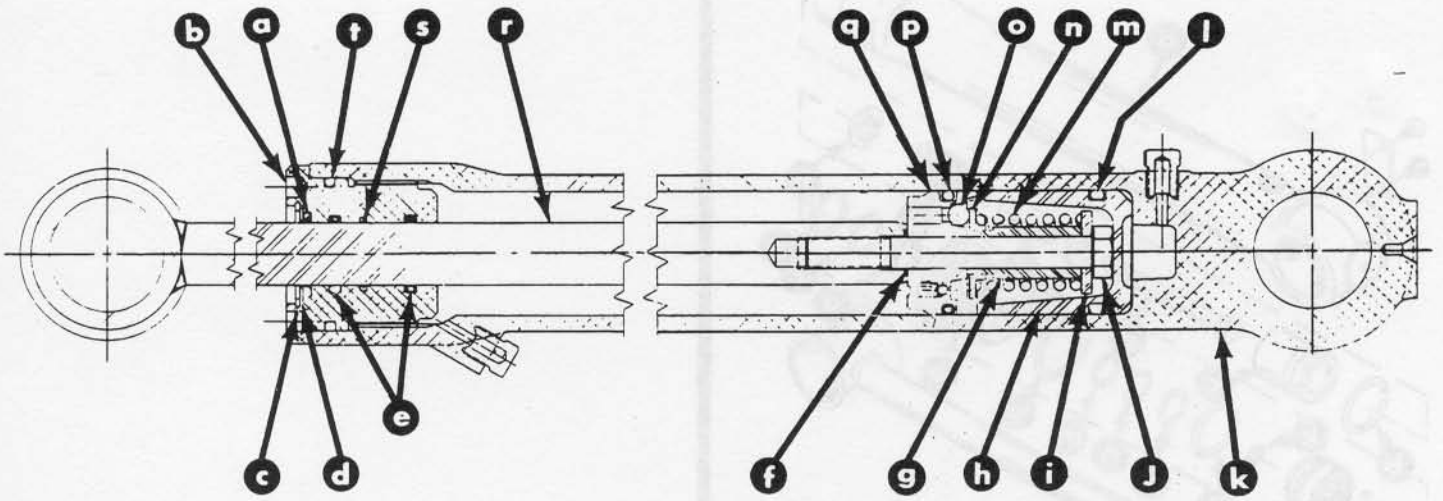
3. Remove components shown: discard all"O" rings.
   - Floating piston (c) - It may be necessary to tap open end of cylinder tube (a) on a block of wood.
   - Floating piston "O" ring (b).
   - Bolt (d), spring guide washer (e), spring guide (f), spring (g), spring guide washer (h), 3 check balls (i), shock piston (j), shock piston to piston rod small "O" ring (k), and shock piston large "O" ring (l) from piston rod (t).
   - End cap (p) - From piston rod (t).
   - Retaining ring (s), plain washer (r), and rod scraper (q) - From end cap (p).
   - "O" ring (o) - From outside of end cap (p).
   - "O" rings (m) - From inside of end cap (p).
   - Continuity spring (n) - From inside end cap (p).
4. Clean all parts in solvent. Be sure all parts are dry before reassembly.



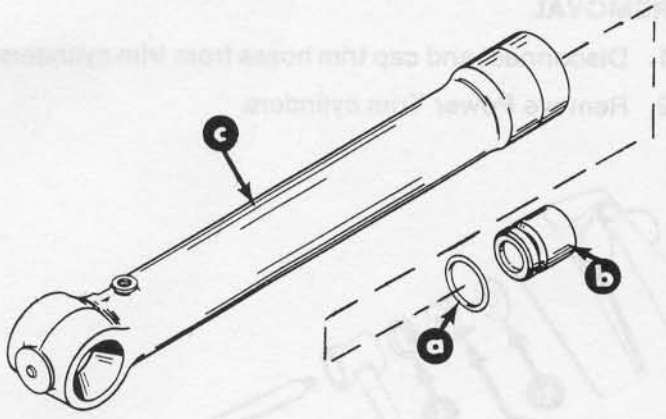
REASSEMBLY

NOTE: Before reassembly, lubricate all internal parts with SAE 10W-30 or 10W-40 motor oil.

1. • Install rod scraper (a), plain washer (d), and retaining ring (a) into end cap (b).
   - Install continuity ring (s) into middle groove and both "O" rings (e) in outermost grooves inside end cap (b).
   - Install large "O" ring (t) on outside of end cap (b).
   - Slide end cap (b) over piston rod (r).
   - Assemble shock piston assembly: Install "O" ring (p) on shock piston (q). Place 3 check balls (o) in shock piston (q). Install spring guide washer (n), spring (m), plain washer (i) and bolt (j) (insert into shock piston).
   - Secure shock piston assembly to piston rod (r). Torque bolt (j) to 15-20 lbs. ft. (20-27 N.m), after applying Loctite "A" 92-32609 to threads.



2. • Install floating piston "O" ring.
   • Install floating piston into cylinder tube.

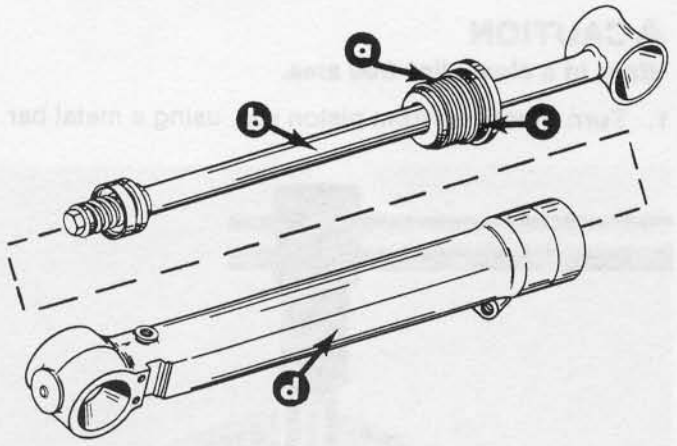


a - "O" Ring
b - Floating Piston
c - Cylinder Tube

⚠CAUTION

Use only grease on end cap threads. Other substances may cause poor electrical continuity between cap and cylinder which could cause a corrosion problem.

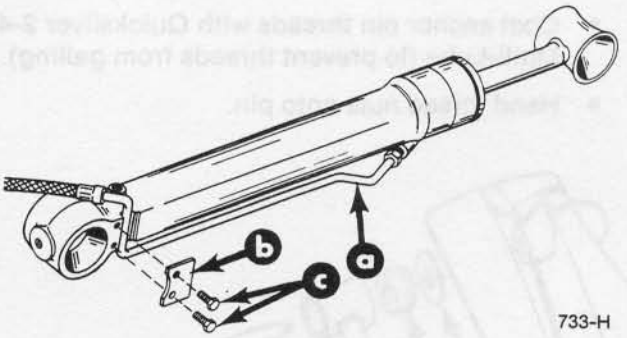
3. • Grease end cap threads.
   • Install piston rod assembly into cylinder tube.
   • Tighten end cap securely.



733-H

a - Grease Threads
b - Piston Rod Assembly
c - End Cap - Tighten Securely
d - Cylinder Tube

4. Install "Down" trim hose.



733-H

a - "Down" Trim Hose
b - Clamping Plate
c - Screws

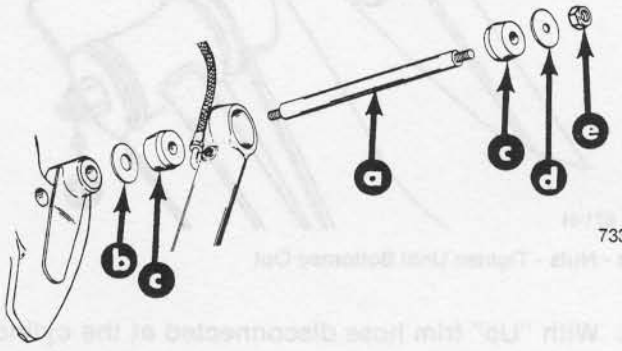
5. Check painted areas of cylinder for scratches that expose metal; paint if necessary.

INSTALLATION

⚠CAUTION

DO NOT apply oil or grease to rubber bushings (in following steps), as this may cause bushings to creep out of position during operation. If lubrication is desired to aid in installing bushings, use 80 parts water to one part soap solution.

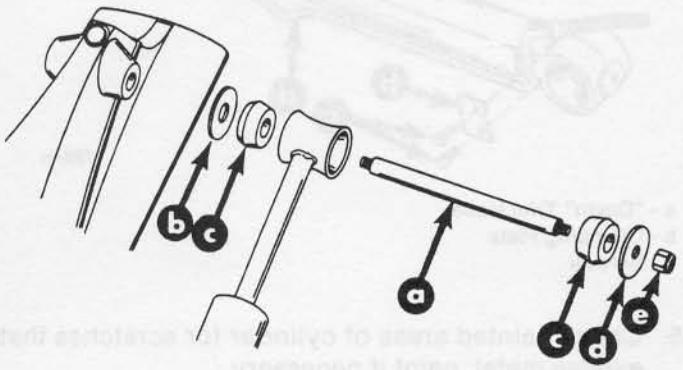
1. • Install forward (longer) anchor pin, bushings, washers and cylinders.
   • Coat anchor pin threads with Quicksilver 2-4-C Multi-Lube (to prevent threads from galling).
   • Hand thread nuts onto pin.



733-H

a - Forward (Longer) Anchor Pin
b - Washers (2) - Large ID
c - Bushings (4)
d - Washers (2) - Small ID
e - Nuts (2)

2. • Install aft (shorter) anchor pin, bushings, washers, and cylinder ends.
   • Coat anchor pin threads with Quicksilver 2-4-C Multi-Lube (to prevent threads from galling).
   • Hand thread nuts onto pin.

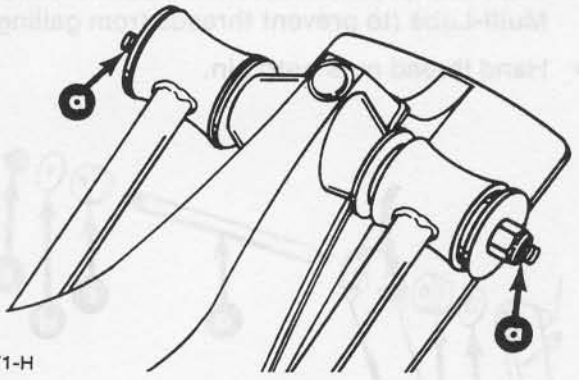


a - Aft (Shorter) Anchor Pin
b - Washers (2) - Large ID
c - Bushings (4)
d - Washers (2) - Small ID
e - Nuts (2)

⚠CAUTION

All 4 anchor pin nuts (on forward and aft anchor pins) MUST BE tightened, as described following, or damage to stern drive unit may result from drive unit moving too far inward.

Tighten nuts on forward and aft anchor pins until nuts and washers bottom out against anchor pin shoulder.



671-H

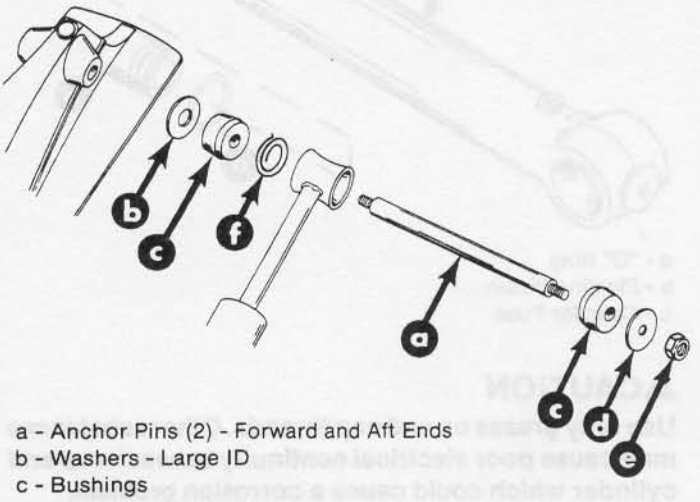
a - Nuts - Tighten Until Bottomed Out

4. With "Up" trim hose disconnected at the cylinder and "Down" hose disconnected at hydraulic connector, air-bleed Power Trim system, as explained under "Power Trim Pump - Air Bleeding Power Trim System" (see "Index").

Internal Return Line Trim Cylinder Repair

REMOVAL

1. Disconnect and cap trim hoses from trim cylinders.
2. Remove Power Trim cylinders.



a - Anchor Pins (2) - Forward and Aft Ends
b - Washers - Large ID
c - Bushings
d - Washers - Small ID
e - Nuts
f - Spiral Ground Springs

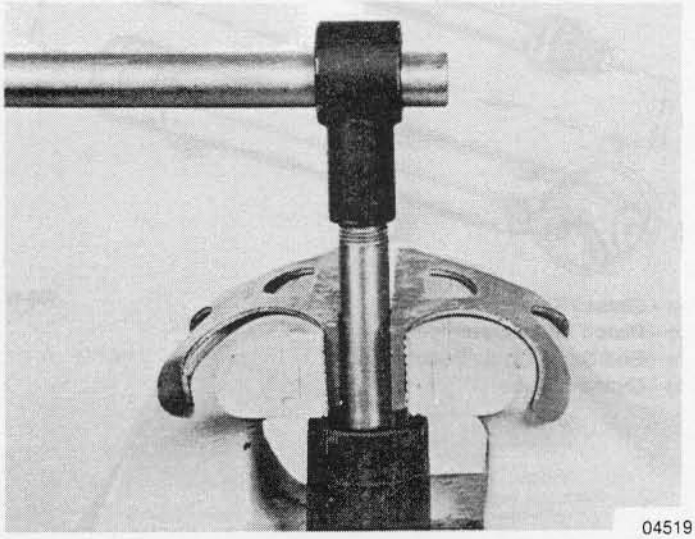
637-H

DISASSEMBLY

⚠CAUTION

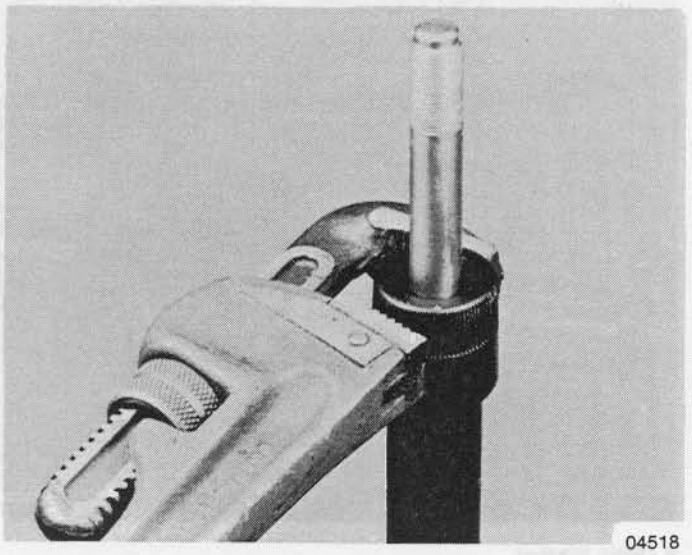
Work in a clean, lint-free area.

1. Turn pivot end from piston rod, using a metal bar.

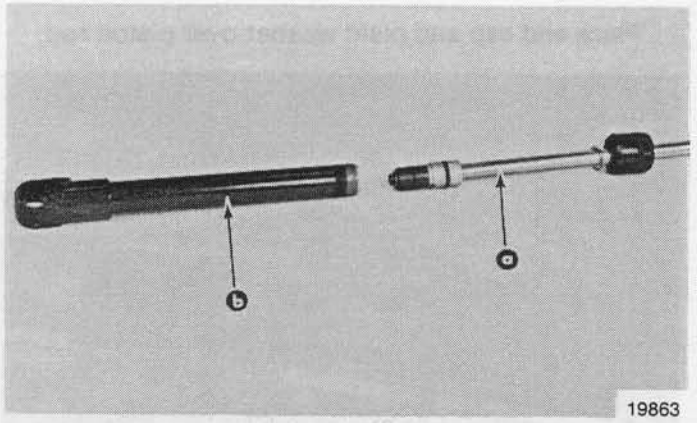


04519

2. Loosen end cap from outer cylinder with a pipe wrench.

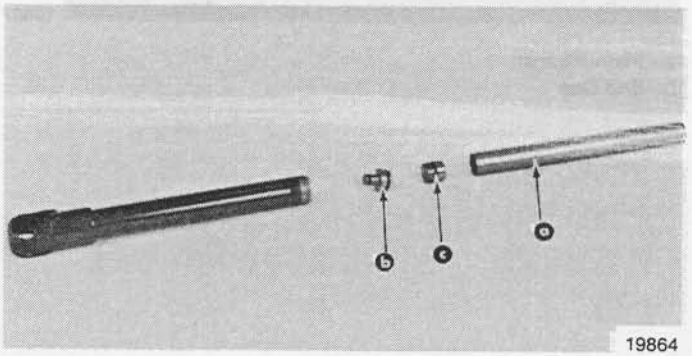


3. Remove piston rod assembly.



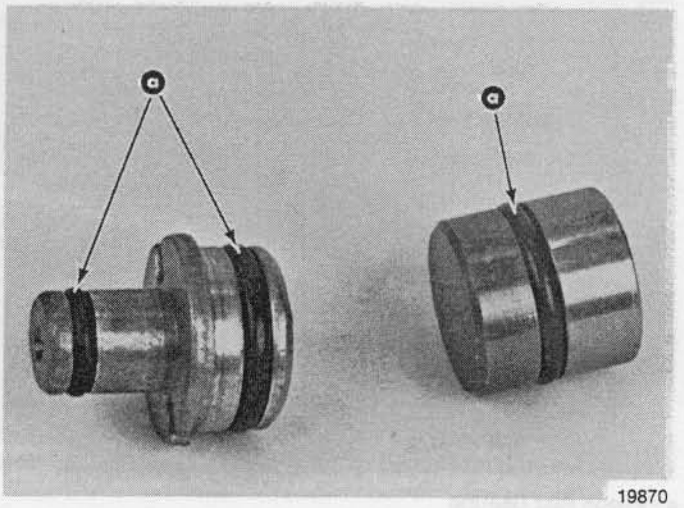
a - Piston Rod Assembly
b - Outer Cylinder

4. Remove components shown.



a - Inner Tube
b - Inner Tube Support
c - Floating Piston

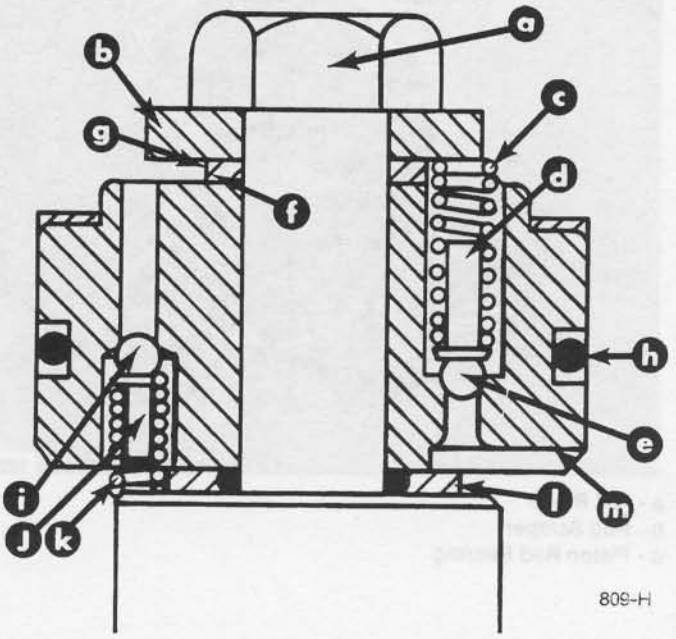
5. Remove floating piston and inner tube support "O" rings.



a - "O" Rings

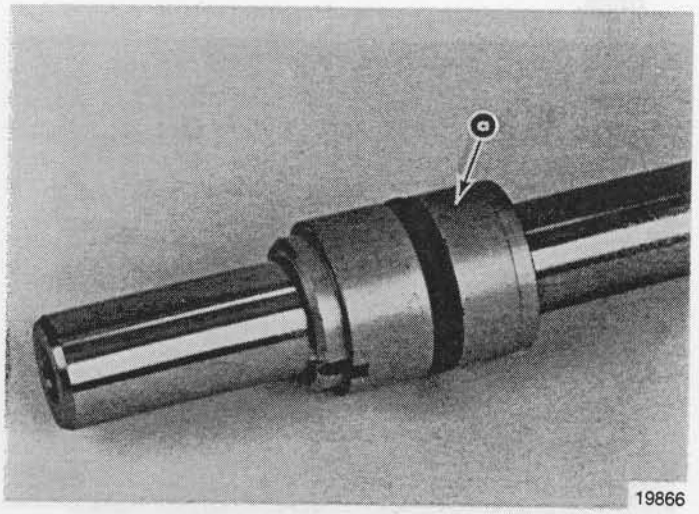
6. NOTE: If shock piston assembly is to be reused, take precautions not to lose check balls and springs during removal. Hold in upright position.

   Remove shock piston assembly from piston rod.



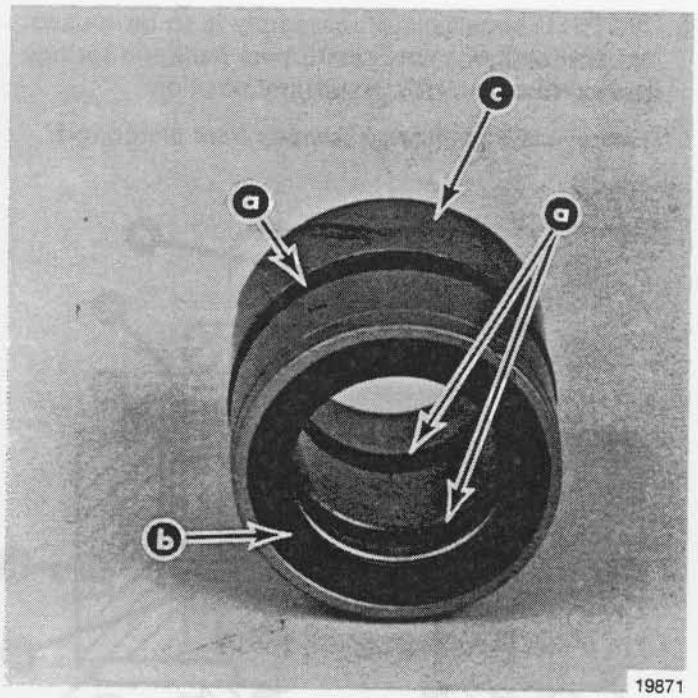
a - Screw (or Nut on Some Cylinders)
b - Plain Washer
c - Spring (7)
d - Tubular Rivet (7)
e - Check Ball (7)
f - Shim Washer
g - Plain Washer
h - "O" Washer
i - Check Ball
j - Tubular Rivet (2)
k - Spring
l - Sealing Washer
m - Shock Piston Assembly

7. Remove piston rod bearing.



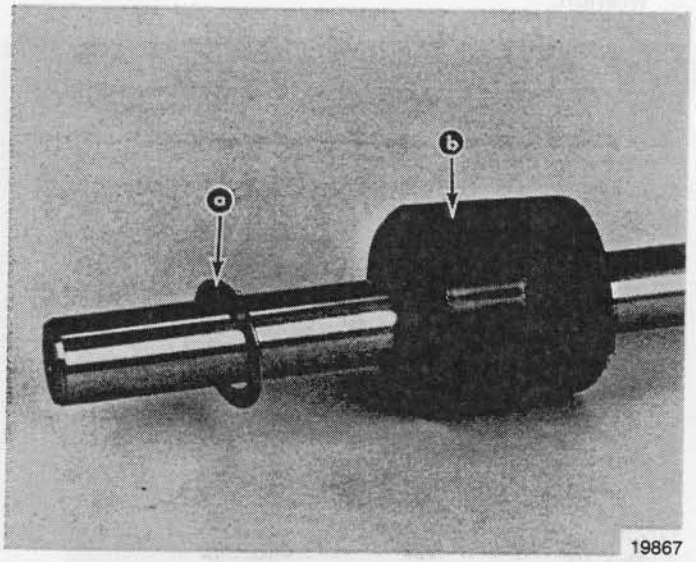
a - Piston Rod Bearing

8. Remove components shown.



a - "O" Rings
b - Rod Scraper
c - Piston Rod Bearing

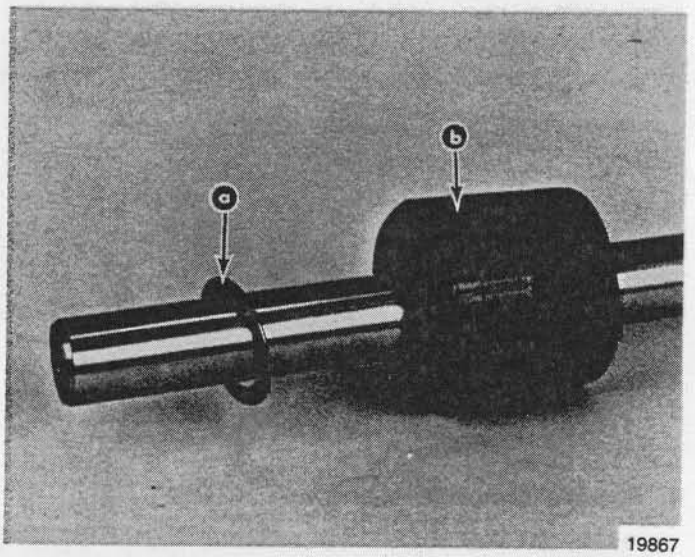
9. Remove plain washer and end cap.



a - Plain Washer
b - End Cap

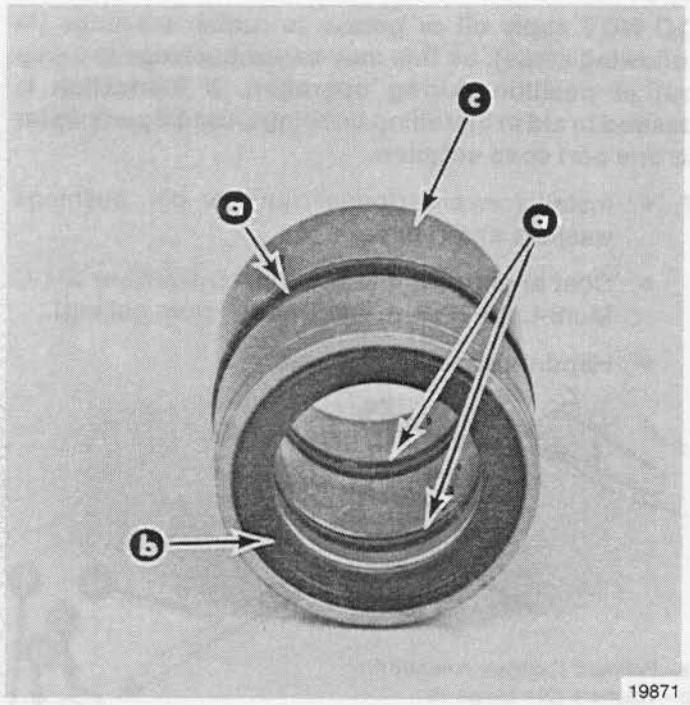
REASSEMBLY

1. Place end cap and plain washer over piston rod.



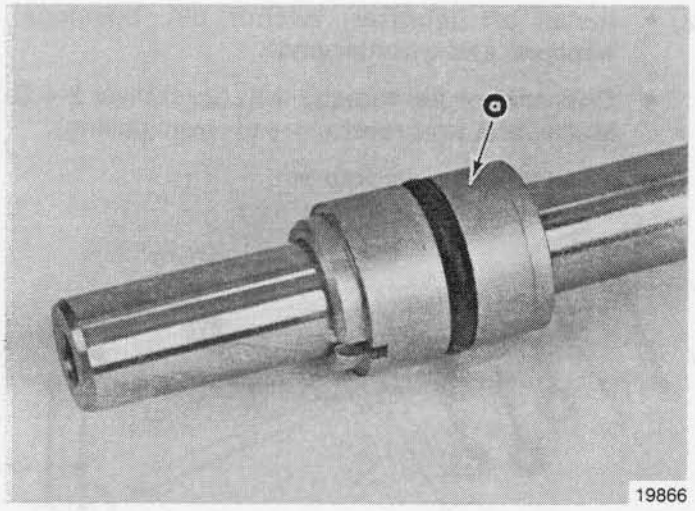
a - Plain Washer
b - End Cap

2. Install "O" rings and rod scraper on piston rod bearing.



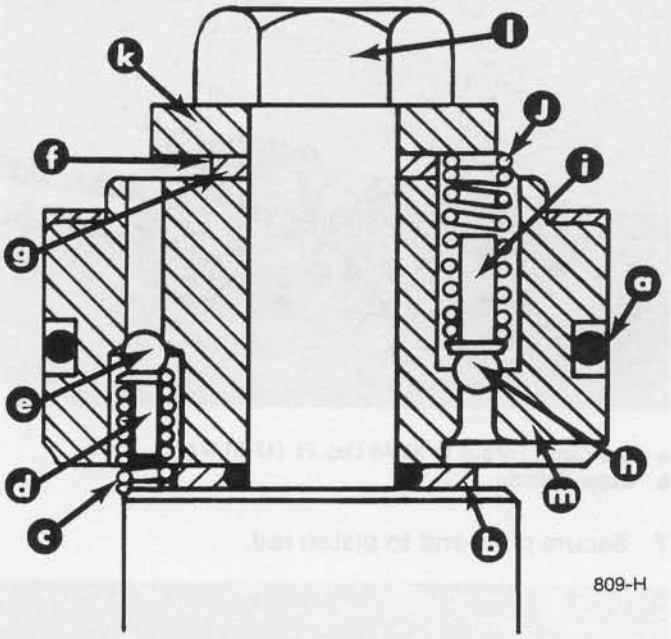
a - "O" Rings
b - Rod Scraper
c - Piston Rod Bearing

3. Place piston rod bearing over piston rod.



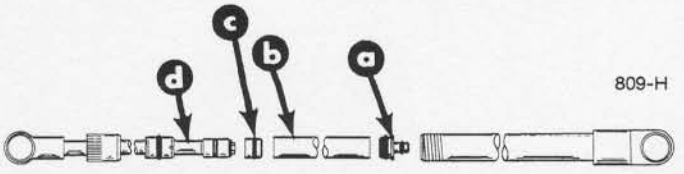
a - Piston Rod Bearing

4. Making sure new "O" ring is installed on shock piston and all shock piston assembly components are in place, secure shock piston assembly to piston rod.



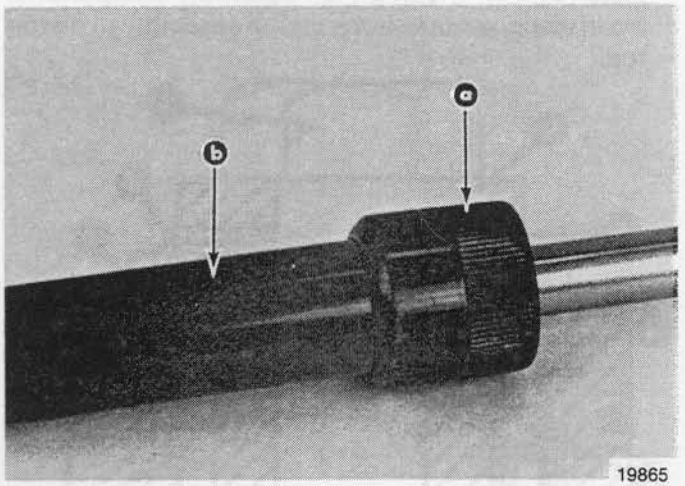
a - "O" Ring
b - Sealing Washer
c - Spring
d - Tubular Rivet (2)
e - Check Ball
f - Plain Washer
g - Shim Washer
h - Check Ball (7)
i - Tubular Rivet (7)
j - Spring (7)
k - Plain Washer
l - Screw - Torque to 15-20 Lbs. Ft. (20-27 N.m)
m - Shock Piston Assembly

5. Install components shown into outer cylinder.



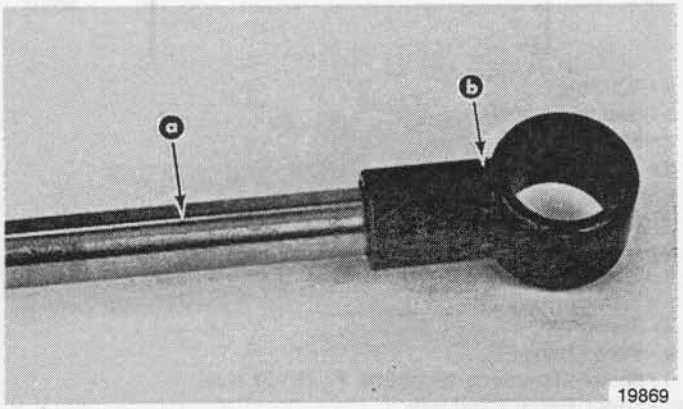
a - Inner Tube Support
b - Inner Tube
c - Floating Piston
d - Piston Rod Assembly

6. Secure end cap to outer cylinder.



a - End Cap - Torque to 35-45 Lbs. Ft. (47-61 N.m)
b - Outer Cylinder

7. Secure pivot end to piston rod.



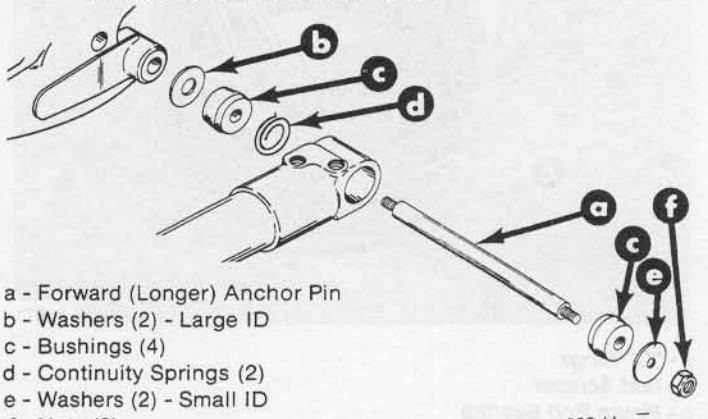
a - Piston Rod - Apply Loctite "A" to Threads
b - Pivot End - Torque to 30-40 Lbs. Ft. (41-54 N.m)

INSTALLATION

⚠CAUTION

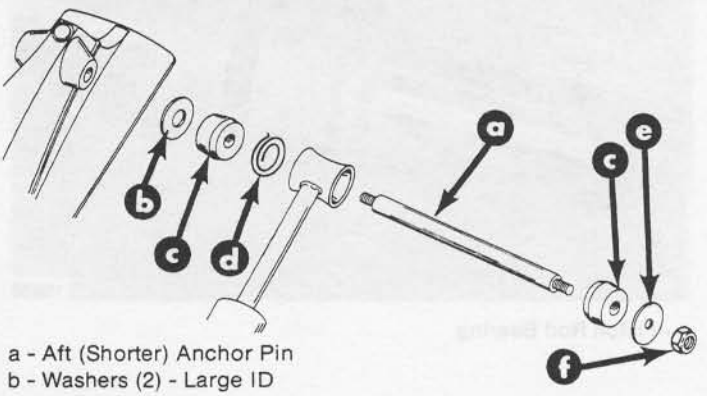
DO NOT apply oil or grease to rubber bushings (in following steps), as this may cause bushings to creep out of position during operation. If lubrication is desired to aid in installing bushings, use 80 parts water to one part soap solution.

1. • Install forward (longer) anchor pin, bushings washers and cylinders.
   • Coat anchor pin threads with Quicksilver 2-4-C Multi-Lube (to prevent threads from galling).
   • Hand thread nuts onto pin.



a - Forward (Longer) Anchor Pin
b - Washers (2) - Large ID
c - Bushings (4)
d - Continuity Springs (2)
e - Washers (2) - Small ID
f - Nuts (2)

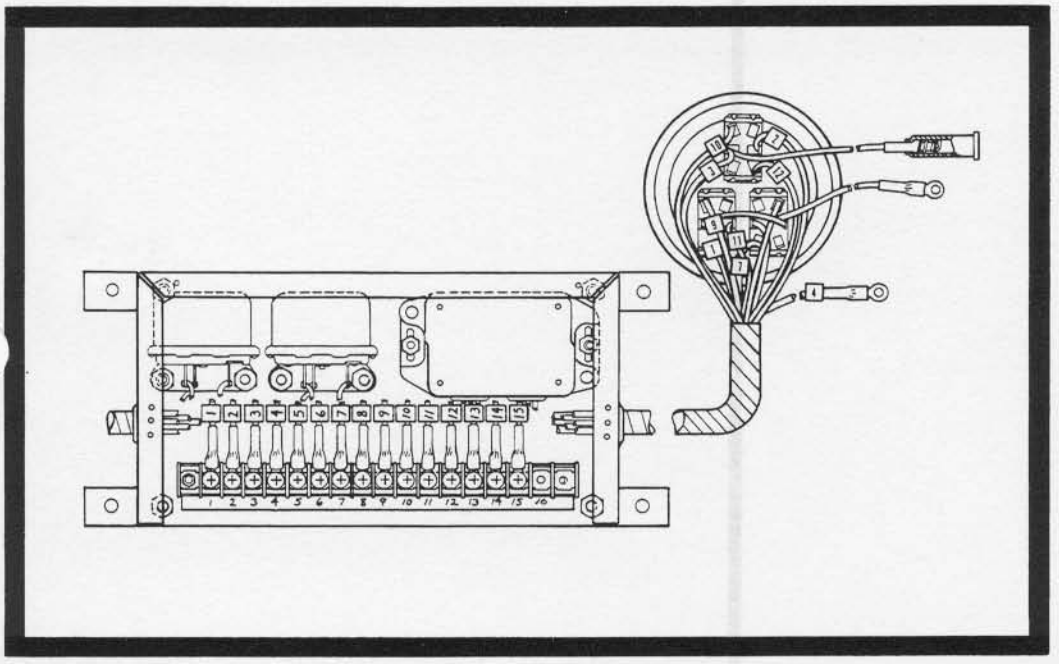
2. • Install aft (shorter) anchor pin, bushings, washers, and cylinder ends.
   • Coat anchor pin threads with Quicksilver 2-4-C Multi-Lube (to prevent threads from galling).
   • Hand thread nuts onto pin.



a - Aft (Shorter) Anchor Pin
b - Washers (2) - Large ID
c - Bushings (4)
d - Continuity Springs (2)
e - Washers (2) - Small ID
f - Nuts (2)

3. Tighten all 4 anchor pin nuts until 2 threads are exposed on each nut. DO NOT OVERTIGHTEN.
4. With "Up" trim hose disconnected at the cylinder, and "Down" hose disconnected at hydraulic connector, air-bleed Power Trim system, as explained under "Power Trim Pump - Air-Bleeding Power Trim System" (see "Index").

POWER TRIM



DUAL POWER TRIM CONTROL

5

E

mercruiser
STERN DRIVES & INBOARDS

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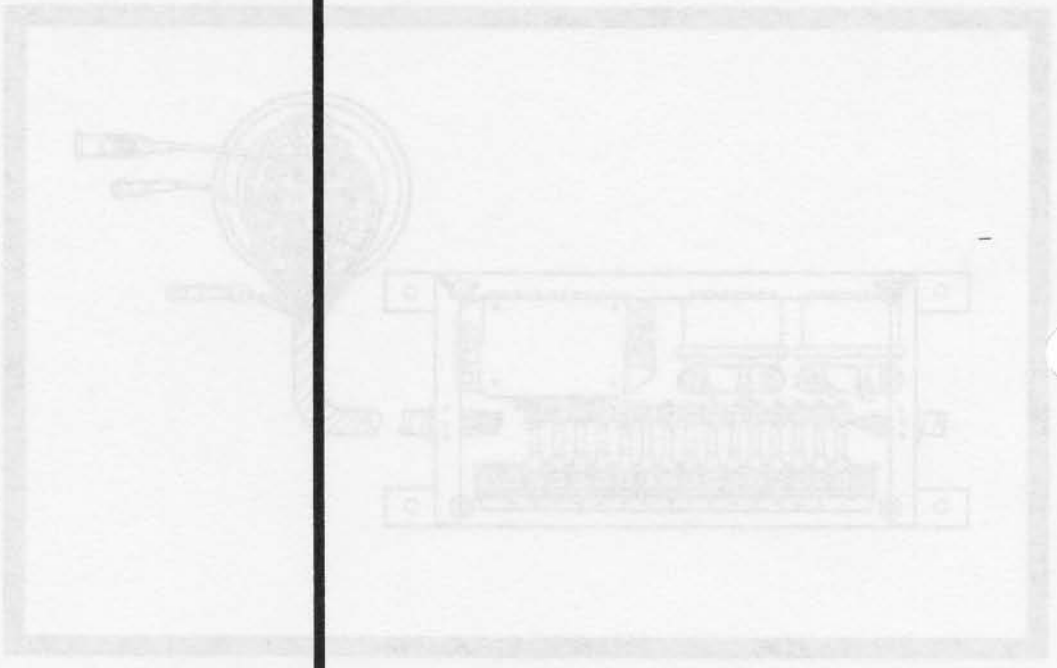


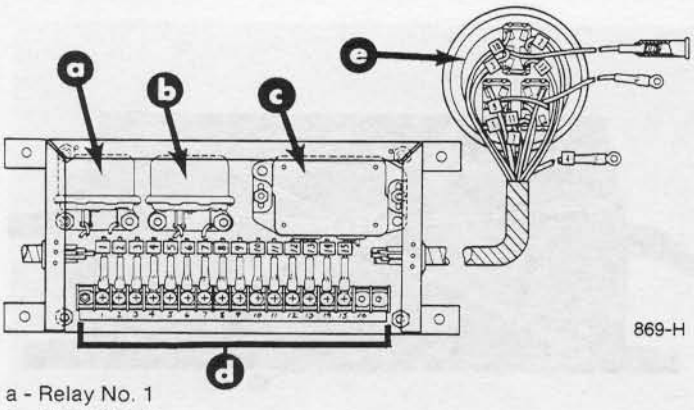
Important Information

When testing this Dual Power Trim System, take special note of the following:

1. Control box harness connectors must be disconnected and key switch must be "OFF".
2. Make certain that the jumper lead used between 3 and 5 is used only when specified.

The tests, listed following, are in a sequence according to probability of component failure. It is recommended, however, that all tests be performed even if a faulty component is detected early in the sequence. This precaution will guard against repeat failure if there is more than one failed component.

Testing Dual Power Trim System



a - Relay No. 1
b - Relay No. 2
c - Diode Module
d - Terminal Block
e - Control Panel

Dual Trim Control Panel Wiring Diagram

Relay Test

1. **Testing Relay No. 1**
   a. Test for 12 volts at terminal 2, using only terminal 4 as a ground.
      - Voltage indicated, proceed to "b".
      - No voltage indicated, replace relay.
   b. Connect a jumper wire between terminals 3 and 5. Test for 12-volts at terminal 2, using only terminal 4 as a ground.
      - No voltage indicated, relay ok.
      - Voltage indicated, replace relay.
2. **Testing Relay No. 2**
   a. Test for continuity between terminals 13 and 9.
      - Continuity indicated, proceed to "b".
      - No continuity indicated, replace relay.
   b. Connect a jumper wire between terminals 3 and 5. Test for continuity between terminals 13 and 9.
      - No continuity indicated, relay OK.
      - Continuity indicated, replace relay.

Diode Module Test

Perform the following diode tests using an ohmmeter set on Rx1 scale. When testing diodes, take 2 readings. Note first reading; then, reverse meter leads again noting reading.

If diode is good, meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading (below 60 ohms) when connected the other way.

If both readings are high or infinite, diode is open. Replace diode module.

If both readings are low, diode is shorted. Replace diode module.

Diode No. 1

Connect a jumper wire between terminals 3 and 5. Test diode between terminals 9 and 10.

Diode No. 2

Connect a jumper between terminals 3 and 5. Test diode between terminals 10 and 13.

⚠CAUTION

Before proceeding with further diode testing, remove fuse from red/purple harness lead so that it will not be possible to short either control box or VOA meter.

Diode No. 3

Test diode between terminals 6 and 12.

Diode No. 4

Test diode between termianls 12 and 7.

Diode No. 5

Test diode between terminals 8 and 11.

Diode No. 6

Test diode between terminals 14 and 15.

Diode No. 7

Test diode between terminals 8 and 15.

Diode No. 8

Test diode between terminals 5 and 15.

Trailer Switch Test

⚠CAUTION

Remove fuse from red/purple harness lead before proceeding with test.

1. Set ohmmeter on Rx1 scale.
2. Push down on "TRAILER" switch and check for continuity between terminals 10 and 3.
   - Continuity indicated, proceed to step 3.
   - No continuity indicated, replace switch.
3. Push up on "TRAILER" switch and check for continuity between terminals 2 and 12.
   - Continuity indicated, switch ok.
   - No continuity indicated, replace switch.

Starboard Trim Switch Test

1. Set ohmmeter on Rx1 scale.
2. Push down on "STBD TRIM" switch and check for continuity between terminals 1 and 9.
   - Continuity indicated, proceed to step 3.
   - No continuity indicated, replace switch.
3. Push up on "STBD TRIM" switch and check for continuity between terminals 11 and 6.
   - Continuity indicated, switch ok.
   - No continuity indicated, replace switch.

Port Trim Switch Test

1. Set ohmmeter on Rx1 scale.
2. Push down on "PORT TRIM" switch and check for continuity between terminals 2 and 13.
   - Continuity indicated, proceed to step 3.
   - No continuity indicated, replace switch.
3. Push up on "PORT TRIM" switch and check for continuity between terminals 14 and 7.
   - Continuity indicated, switch ok.
   - No continuity indicated, replace switch.

Dual Power Trim System Component Repair

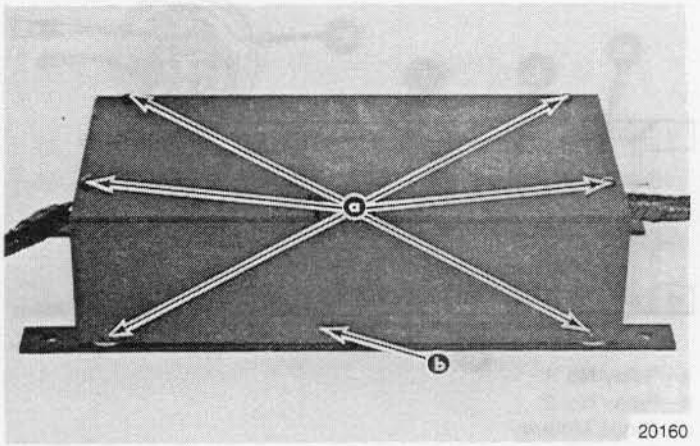
Important Information

All original wiring and wiring for replacement components are numbered to correspond with their respective terminal block locations. Also, use wiring diagram, following, as a guide during wiring installation.

Use care when removing and installing components. Do not force or pull wiring during replacement. Use care to prevent wiring from stretching, pinching or chafing. Coat all terminal connections with Liquid Neoprene.

Relay Replacement

1. Remove control box cover.



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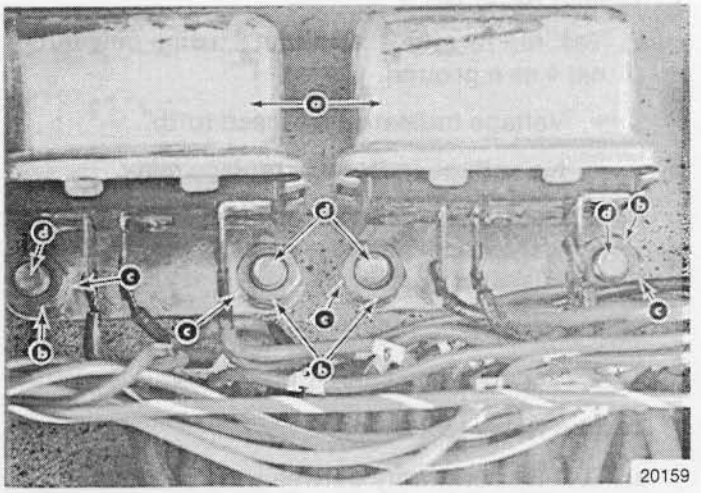
a - Screws
b - Cover

2. Disconnect leads from terminal block.
3. Replace relay assembly.



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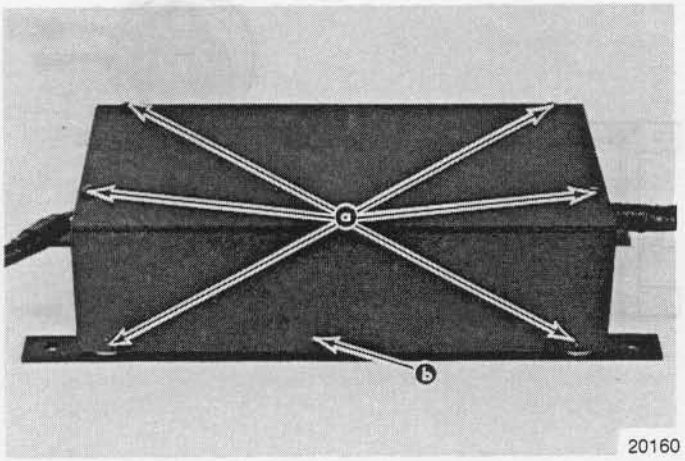
a - Relay Assemblies (1 and 2)
b - Nuts
c - Washers
d - Screws

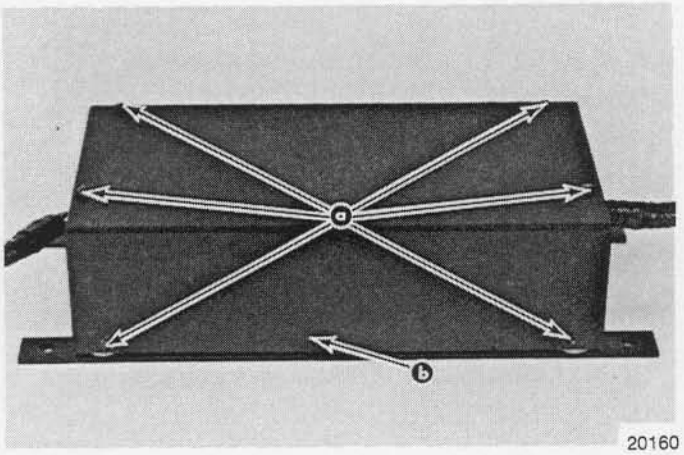
4. Reconnect numbered leads to respective terminals.
5. Install control box cover.



a - Screws
b - Cover

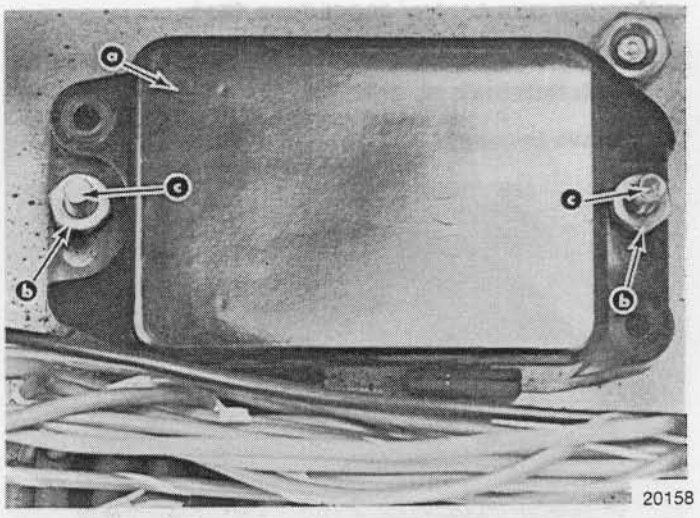
Diode Module Replacement

1. Remove control box cover.



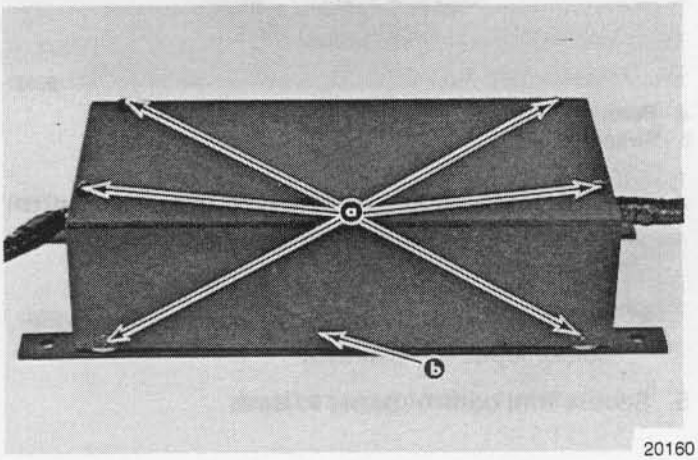
a - Screws
b - Cover

2. Disconnect leads from terminal block.
3. Replace diode module.



a - Diode Module
b - Nuts
c - Screws

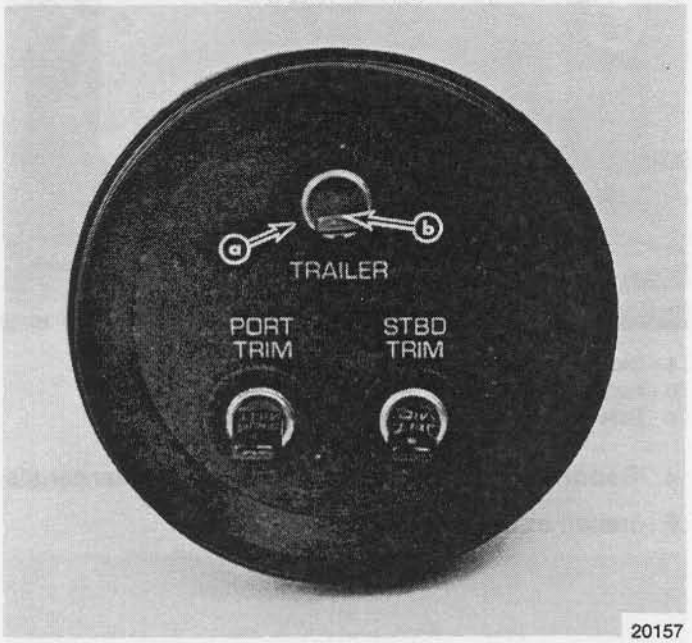
4. Reconnect numbered leads to respective terminals.
5. Install control box cover.



a - Screws
b - Cover

Trim Control Panel Switch(es) Replacement

1. Remove trim control panel from dash.
2. Cut leads (from switch to be replaced) as close to switch terminals as possible.
3. Remove bezel nut and replace switch.

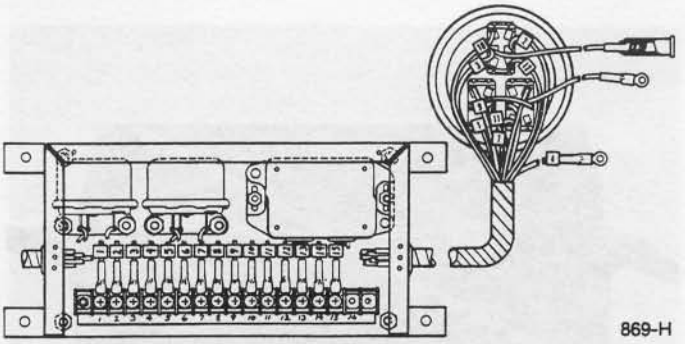


20157

a - Bezel Nut
b - Switch
1 Per Switch

4. • With new switch properly positioned in control panel, loop leads through their respective terminal eyelets.
   • Using 60-40 tin-lead alloy rosin core solder, solder leads to terminals.
5. Secure trim control panel to dash.

Dual Trim Control Panel Wiring Diagram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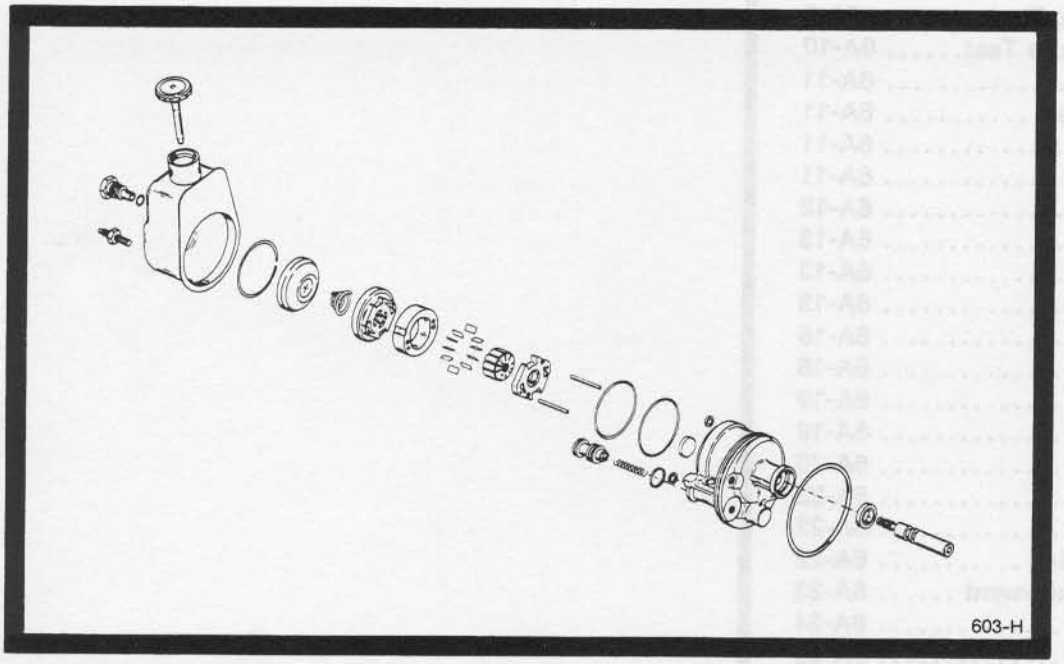
STEERING SYSTEMS



POWER STEERING

6

A

mercruiser
STERN DRIVES & INBOARDS

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Special Tools

Description	Part No.
Power Steering Test Gauge	91-38053A3
Power Steering Pump Pulley Remover	Ken Moore Part No. J-25034 or J-21239-1
Power Steering Pump Pulley Installer	91-93656A1

Quicksilver Lubricants, Adhesives, and Sealers

Description	Part No.
2-4-C Multi-Lube	92-90018-12
Special Lubricant 101	92-79214A1
Loctite Primer T	92-59327-1
Loctite No. 35	92-59328-1

Description

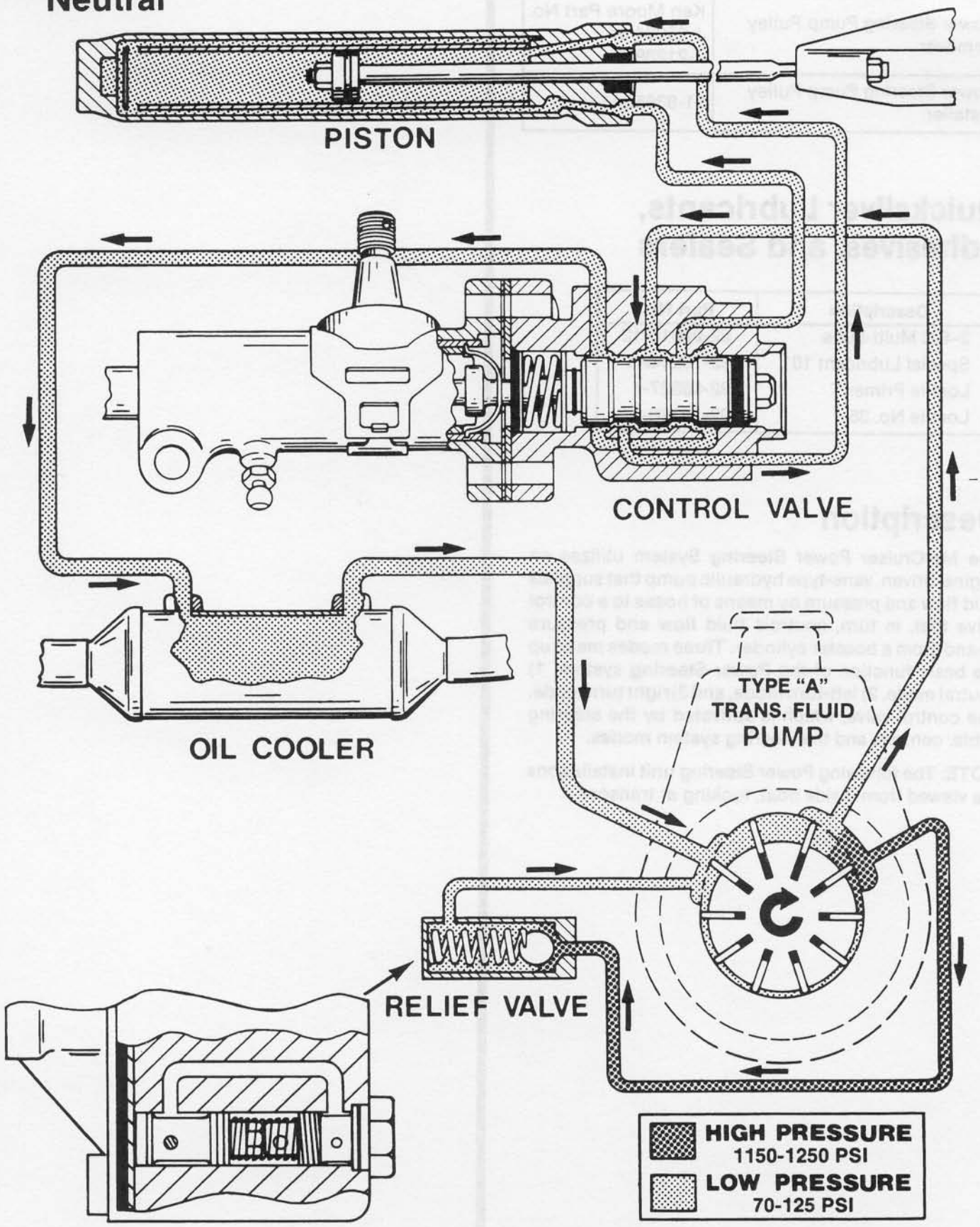
The MerCruiser Power Steering System utilizes an engine-driven, vane-type hydraulic pump that supplies fluid flow and pressure by means of hoses to a control valve that, in turn, controls fluid flow and pressure to-and-from a booster cylinder. Three modes make up the basic function of the Power Steering system: 1) neutral mode, 2) left-turn mode, and 3)right turn mode. The control valve, which is activated by the steering cable, controls and the steering system modes.

NOTE: The following Power Steering unit installations are viewed from inside boat, looking at transom.

MerCruiser Power Steering System

(VIEWING FROM INSIDE OF BOAT LOOKING AT TRANSOM)

Models TR-TRS
Neutral

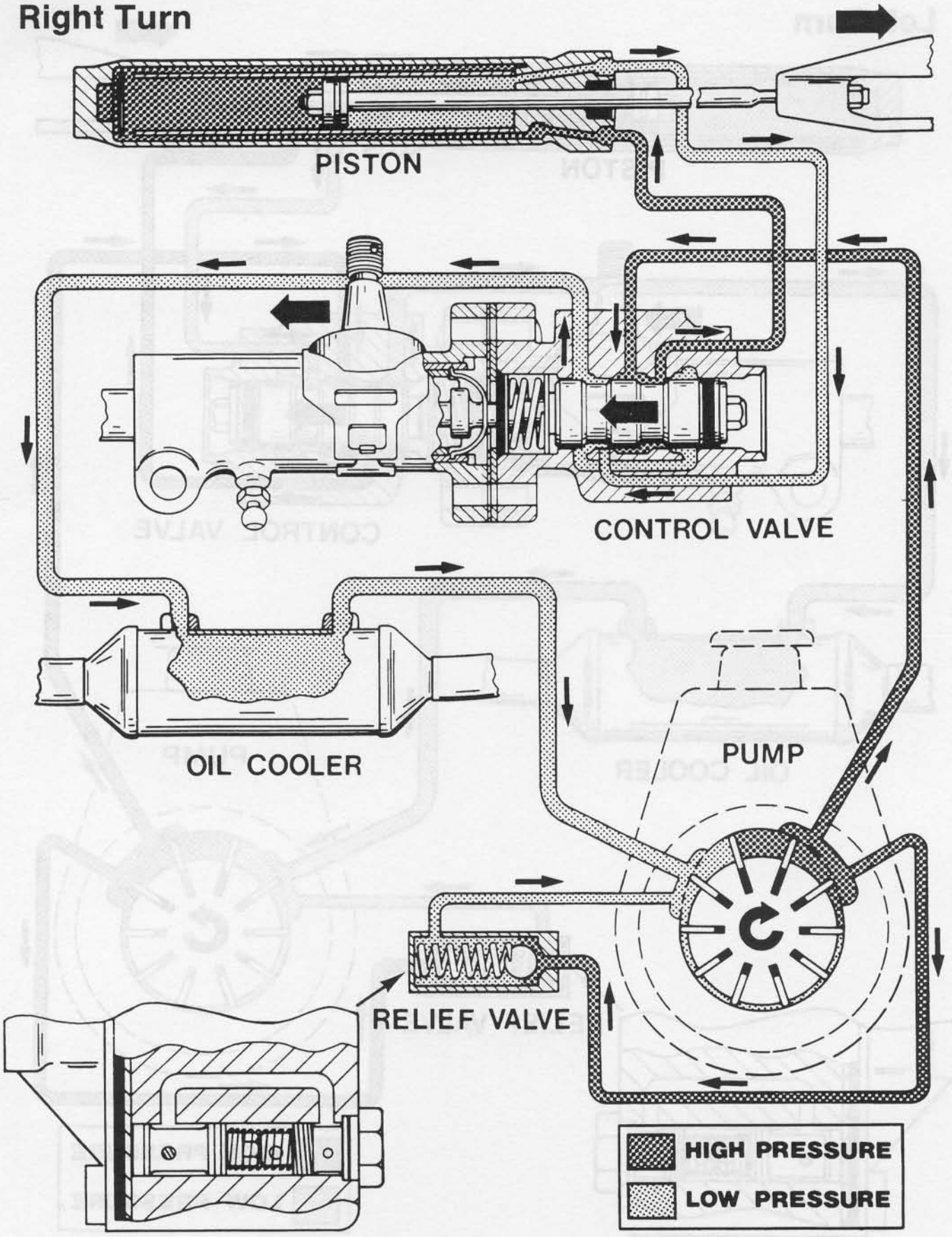


MerCruiser Power Steering System

(VIEWING FROM INSIDE OF BOAT LOOKING AT TRANSOM)

Models TR-TRS

Right Turn

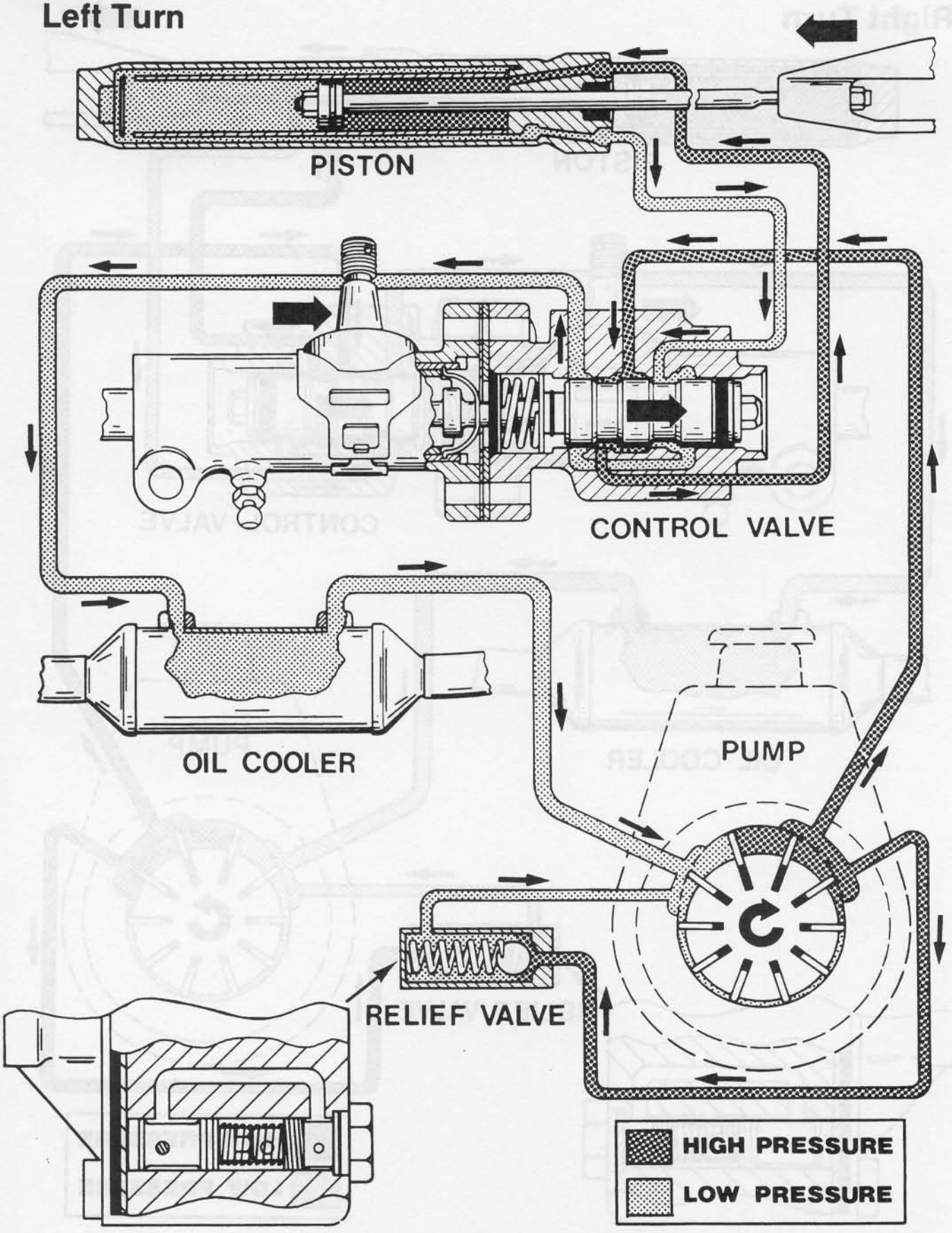


MerCruiser Power Steering System

(VIEWING FROM INSIDE OF BOAT LOOKING AT TRANSOM)

Models TR-TRS

Left Turn



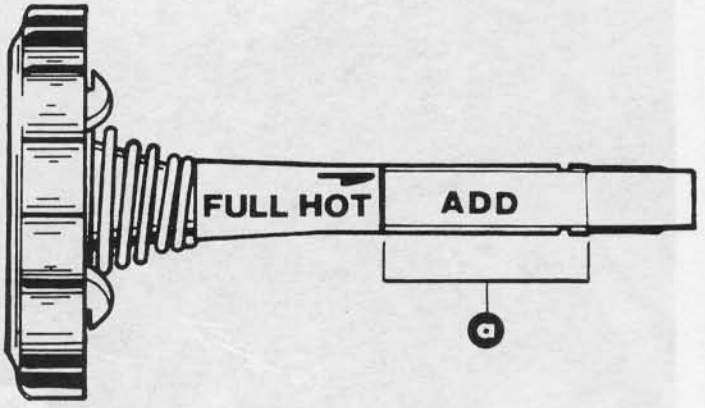
Filling and Air Bleeding Power Steering System

IMPORTANT: Power Steering system MUST BE filled exactly as explained, following, to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause Power Steering system to become spongy, which may result in poor boat control.

1. Position drive unit so that it is straight back.
2. • Remove fill cap.
   • Note level on dipstick.
   • If fluid is below indicated mark on dipstick, add automatic transmission fluid (ATF), Type "F", Dexron, or Dexron II, as required, to bring level up to correct level.

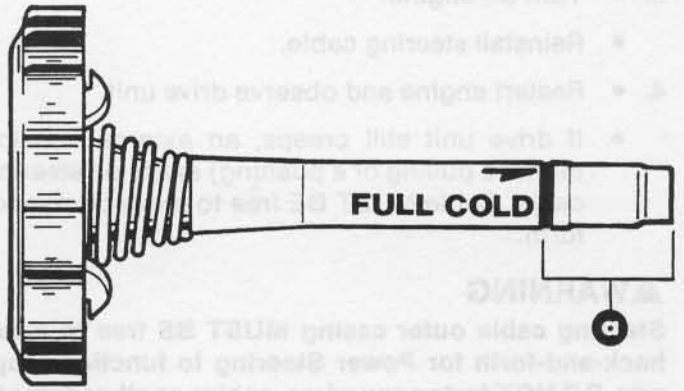
IMPORTANT: Use only Automatic Transmission Fluid (ATF), Type "F". Dexron, or Dexron II in Power Steering system.

- Stop engine.



a - Recommended Fluid Level

Engine Warm from Operation



a - Recommended Fluid Level

Engine Cold

3. • Turn steering wheel back-and-forth to end of travel in each direction several times.
   • Recheck fluid level and add fluid, if necessary.
4. Install fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

- Start engine and run at 1000-1500 RPM until engine reaches normal operating temperature.
- Turn steering wheel back-and-forth to end of travel in each direction several times.

6. Position drive unit so that it is straight back.
   - Stop engine.
   - Remove fill cap.
   - Allow any foam to disperse from pump.
   - Check fluid level -- fluid should be up to "FULL—HOT" mark on dipstick.
   - Add recommended fluid, if necessary, to bring level up to required mark. DO NOT overfill.

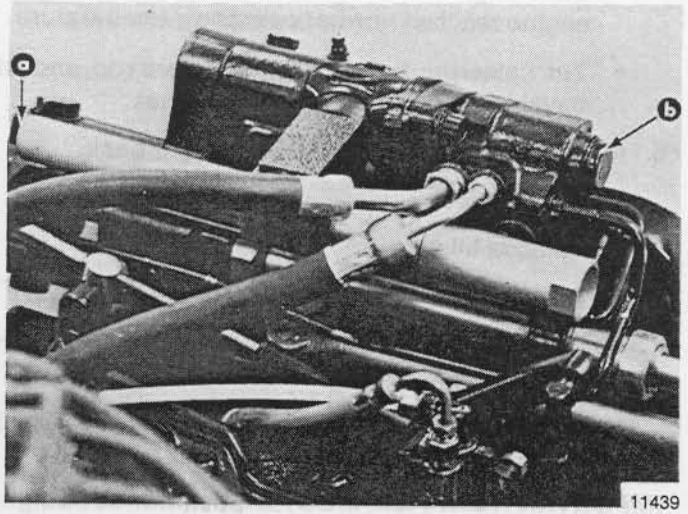
IMPORTANT: Drive unit MUST BE positioned straight back and Power Steering fluid MUST BE hot to accurately check fluid level.

7. If fluid is still foamy, repeat STEP 3, 5, and 6 until fluid does not foam and level remains constant.

Balancing Power Steering Control Valve

Perform the following if stern drive unit tends to creep in one direction or the other, with engine running, drive unit in neutral and hands off the steering wheel.

1. • Turn engine off.
   • Remove steering cable.
   • Remove dust cover.



a - Steering Cable Removed
b - Control Valve Dust Cover

2. **IMPORTANT: DO NOT move adjusting nut more than necessary (as explained following), as excessive movement could cause nut to lose its friction-locking qualitites.**

Start engine and adjust control valve adjusting nut, as follows:

- **If piston rod end clevis moves toward right (starboard).**

a. Turn nut clockwise until clevis JUST begins to move to the left.

b. Turn nut counterclockwise until clevis JUST begins to move to the right.

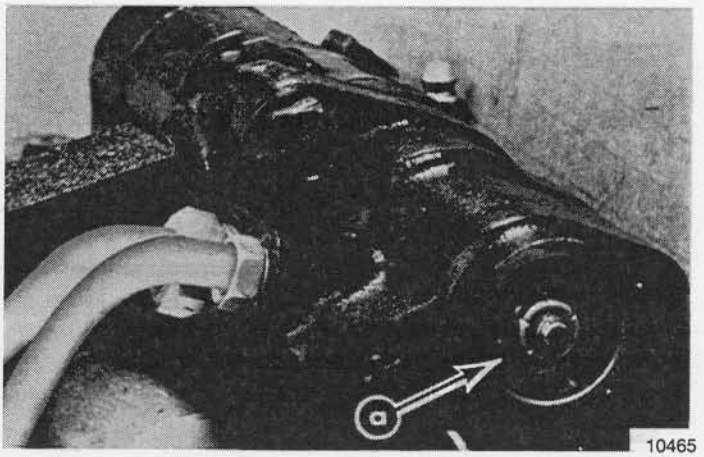
c. Turn nut clockwise to exactly 1/2 the rotation needed to change direction of rod end clevis movement.

- **If piston rod end clevis moves toward left (port),**

a. Turn nut counterclockwise until clevis JUST begins to move to the right.

b. Turn nut clockwise until clevis JUST begins to move to the left.

c. Turn nut counterclockwise 1/2 the rotation needed to change direction of rod end clevis movement.



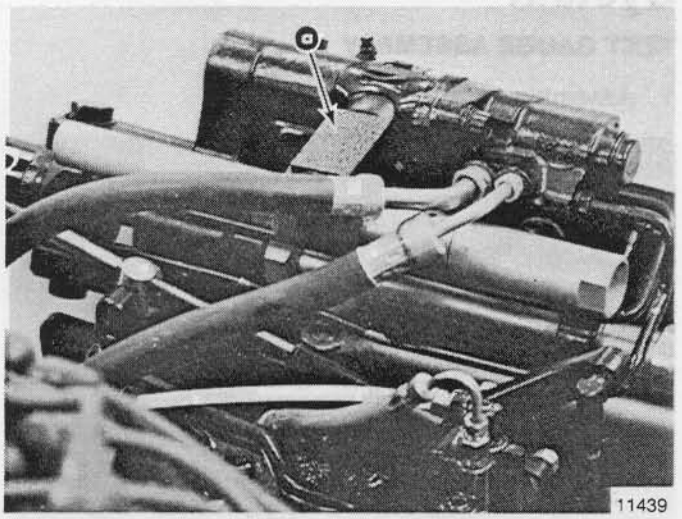
a - Adjusting Nut

3. • Turn off engine.
   • Reinstall steering cable.
4. • Restart engine and observe drive unit.
   • If drive unit still creeps, an external tension (either a pulling or a pushing) exists on steering cable. Cable MUST BE free to move back-and-forth.

⚠WARNING

Steering cable outer casing MUST BE free to move back-and-forth for Power Steering to function properly. DO NOT fasten any wires, cables or other items to steering cable, as this may prevent it from moving.

5. After adjustment is completed, place 2-4-C Multi-Lube in adjusting nut cavity and reinstall dust cover.



a - Dust Cover

Power Steering Drive Belt Inspection

1. Inspect Power Steering pump drive belt on engine for excessive wear, cracks, fraying, and glazed surfaces.
2. • Check belt tension using either of the two methods, following:
   a. Using a strand tension gauge, take gauge reading at mid-point of Power Steering pump drive belt. Reading should be 75-95 lbs. (334-423 N).
   b. Check belt tension by pushing down on upper strand of belt at mid-point of Power Steering pump drive belt. Belt should depress 1/2 in. (13mm).
   • Adjust belt, if required.

Steering Cable Selection, Removal and Installation

SELECTION

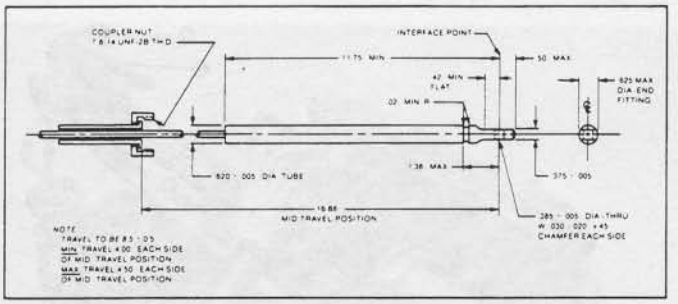
Steering system has the steering cable guide tube set for cables with end dimensions which comply with the BIA Certification Handbook.

⚠CAUTION

If cables with improper dimensions are installed, severe damage to transom assembly and/or steering system may result.

⚠CAUTION

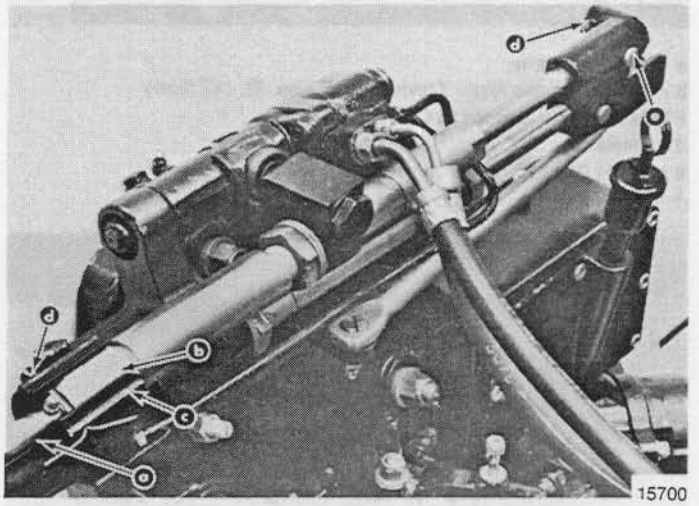
Steering cables MUST BE THE CORRECT LENGTH, particularly when installed in large boats. Sharp bends or too-short cables result in kinks; too-long cables require unnecessary bends and/or loops. Both place an extra stress on the cable. The proper cable is as short as possible, with the fewest bends and with radii as large as possible.



Steering Cable End Dimension

REMOVAL

Remove steering cable.



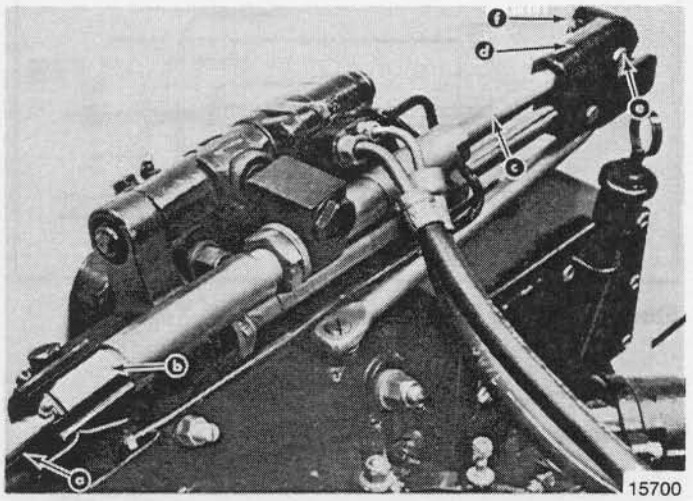
a - Steering Cable
b - Cable Coupler Nut
c - Locking Sleeve
d - Cotter Pins
e - Clevis Pin

INSTALLATION

Liberally coat steering cable end with a liberal amount of Special Lubricant 101 and install cable.

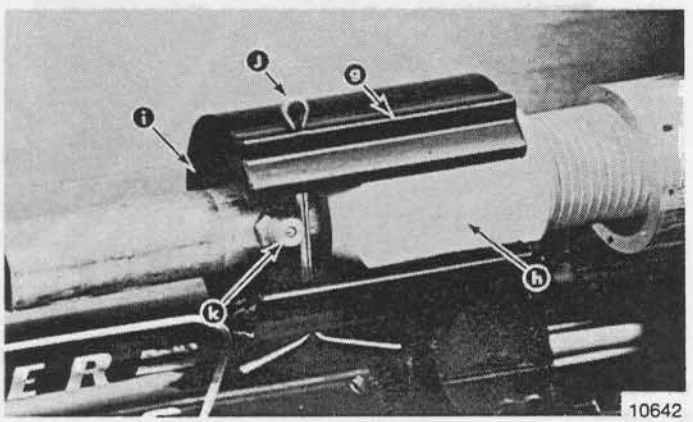
⚠WARNING

Steering cable outer casing MUST BE free to move back-and-forth for steering to function properly. DO NOT fasten any wires, cables or other items to steering cable, as this may prevent it from moving.



15700

a - Steering Cable
b - Cable Coupler Nut - Torque to 35 Lbs. Ft. (47 N.m)
c - Cable End - Secure to Clevis
d - Clevis
e - Clevis Pin
f - Cotter Pin



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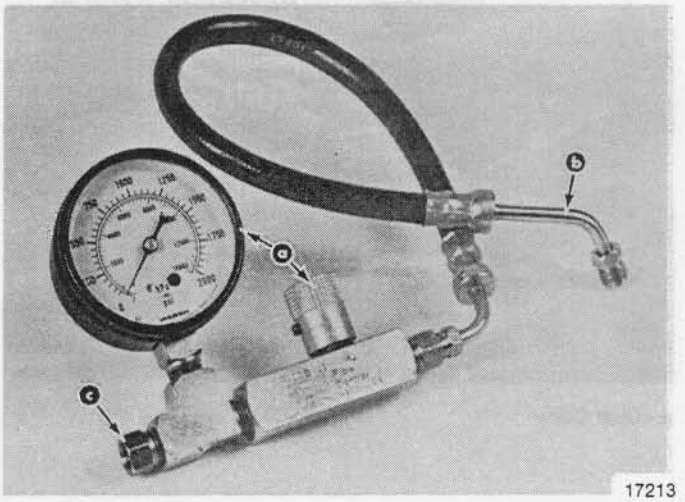
g - Locking Sleeve - Secure to Cable Coupler Nut
h - Cable Coupler Nut
i - Rubber Bumper
j - Cotter Pin
k - Grease Fitting

Testing Power Steering System

TEST GAUGE ASSEMBLY

1. Assemble gauge.

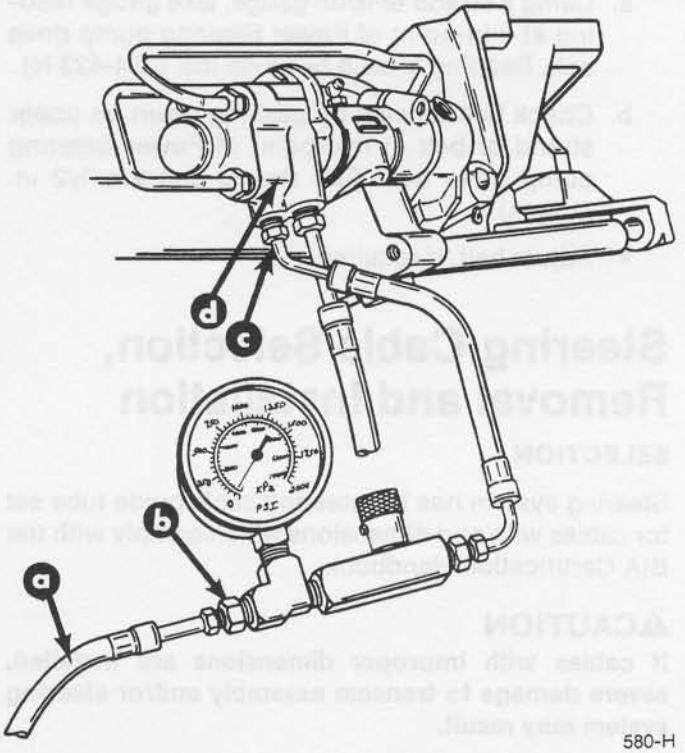


17213

a - Gauge and Valve
b - Hose to Steering Unit
c - Gauge Fitting

Typical Steering Unit

2. Install test gauge assembly between control valve and pump pressure hose. Tighten all fittings securely, but DO NOT OVERTIGHTEN.



580-H

a - Pump Pressure Hose
b - Gauge Fitting
c - Gauge Valve Hose
d - Control Valve

POWER STEERING PUMP LUGGING TEST

⚠WARNING

Steering cable outer casing MUST BE free to move back-and-forth for Power Steering to function properly. Make sure that no wires, cables, or other items are fastened to steering cable, as this may prevent it from moving.

⚠CAUTION

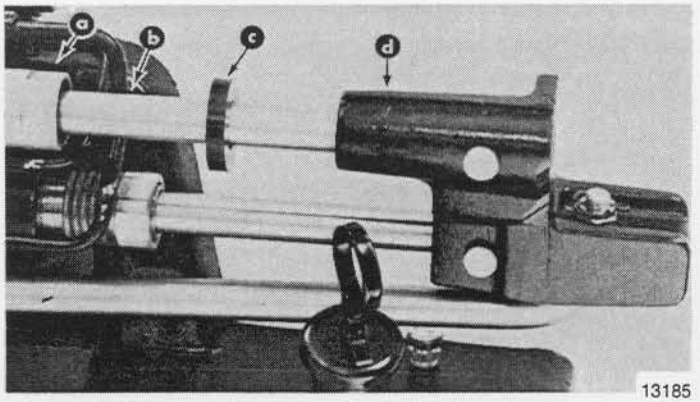
DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠CAUTION

If Power Steering pump lugs when steering wheel is turned to end of travel in either direction (left or right), damage to steering system and/or stern drive may result.

IMPORTANT: Make sure the Power Steering pump is filled to proper level before proceeding. Use only automatic transmission fluid (ATF) Type F, Dexron or Dexron II.

1. Completely open test gauge.
2. Start engine and run at idle speed.
3. • Turn steering wheel to **hard left** and observe reading on gauge.
   • If pressure reading is higher than 300 psi (2069 kPa). Stop engine and check the following:
   a. Check that steering lever is not contacting cutout in transom. If contact is being made, modify cutout.
   b. If "a", above, is not the cause, disconnect steering cable end and install spacer (12-62402) over end of cable. Be sure to reconnect steering cable end correctly.

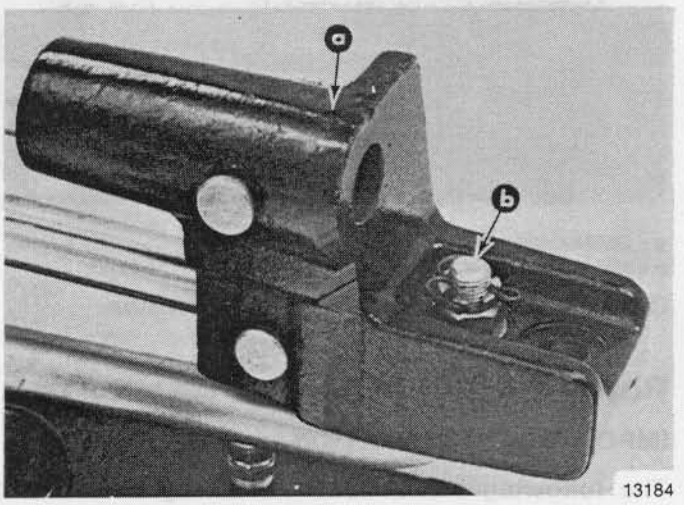


13185

a - Cable Guide Tube
b - Steering Cable End
c - Spacer (12-62402)
d - Cable End Adaptor

Spacer Installed

4. • With engine running, turn steering wheel to **hard right** and observe reading on gauge.
   • If reading is higher than 300 psi (2069 kPa), stop engine and check the following:
   a. That steering lever is not contacting cutout in transom. If contact is being made, modify cutout.
   b. That steering link rod is installed in the innermost hole of the cable end adaptor.

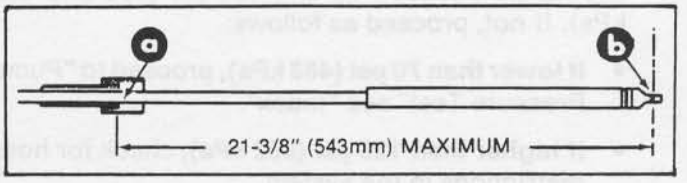


13184

a - Cable End Adaptor
b - Steering Link Rod

Proper Steering Link Rod Installation

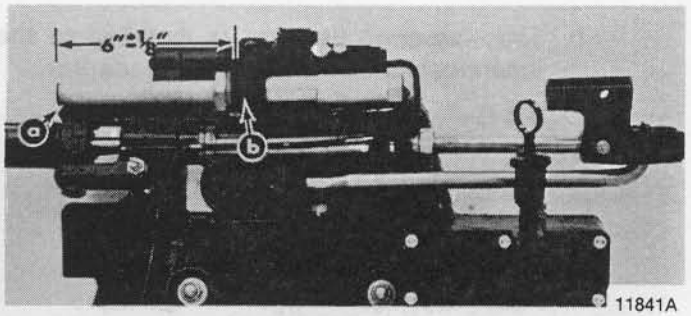
   c. If "a" or "b" is not the cause, remove steering cable from Power Steering unit and check steering cable end dimension with cable FULLY EXTENDED. Dimension from steering cable mounting flange (that butts against guide tube) to center of hole in steering cable end MUST NOT EXCEED 21-3/8 in. (543mm). If dimension is incorrect, replace cable.



a - Steering Cable Mounting Flange
b - Center of Hole in Steering Cable End

Checking Steering Cable End Dimension (with Cable Fullly Extended)

d. With steering cable still removed, check Power Steering unit cable guide tube end dimension. Dimension between end of cable guide tube and adaptor block MUST BE 6 in. ± 1/8 in. (152mm ± 3.2mm). If dimension is incorrect, see "Cable Guide Tube Repair" (see "Index").



a - Cable Guide Tube
b - Adaptor Block

Checking Cable Guide Tube End Dimension

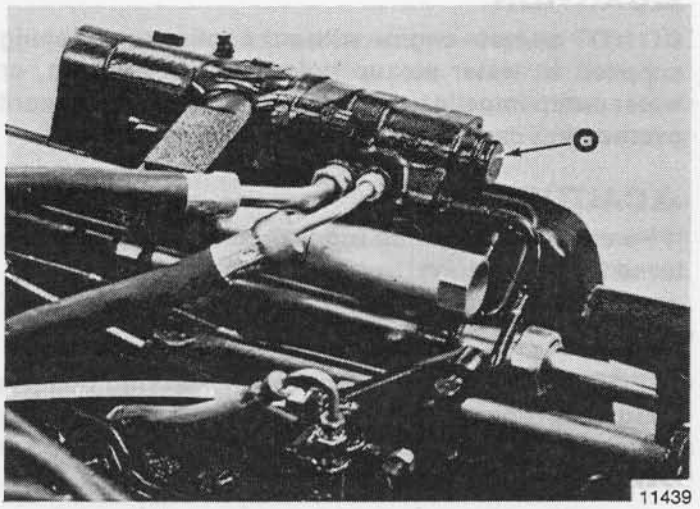
Power Steering System Pressure Test

IMPORTANT INFORMATION

The following instructions are arranged so that a defective part can be detected by the process of elimination. It is suggested that the order of the instructions be followed so that the Power Steering System can be tested effectively.

1. Remove steering cable from Power Steering unit and disconnect Power Steering unit from steering lever.
2. Assemble and install test gauge.
3. Open valve on gauge completely.
4. Start engine and run at 1000-1500 RPM until engine reaches normal operating temperature.
5. With engine at idle speed, test gauge reading should be between 70 and 125 psi (483 and 862 kPa). If not, proceed as follows:
   - **If lower than 70 psi (483 kPa),** proceed to "Pump Pressure Test" see "Index".
   - **If higher than 125 psi (862 kPa),** check for hose restrictions in the system.
6. **⚠CAUTION**
   DO NOT lug pump at maximum pressure for more than 5 seconds, in next step, or damage to Power Steering pump may occur.

   Push control valve adaptor block **momentarily** to the **left** and then to the **right.** Gauge reading should show an instant increase in pressure when block is pushed in both directions.



a - Control Valve Adaptor Block

Push control valve adaptor block to the **right,** until booster cylinder piston rod is fully retracted. With piston rod in this position, **momentarily** push adaptor block to the **right** until maximum pressure reading is obtained.

- **If pressure is above 1000 psi (6897 kPa),** system pressure is good.
- **If pressure is below 1000 psi (6897 kPa),** conduct "Pump Pressure Test", see "Index".

Pump Pressure Test

⚠CAUTION

In performing the following test, DO NOT lug pump at maximum pressure for more than 5 seconds or damage to Power Steering pump may occur.

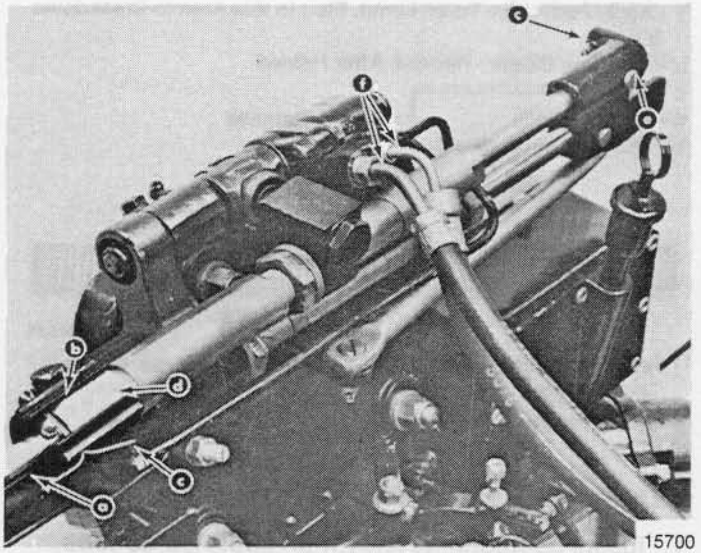
1. Install test gauge.
2. Start engine and run at 1000-1500 RPM until engine reaches normal operating temperature.
3. • Close test gauge valve just long enough to obtain maximum pressure reading.
   • Close and open valve 3 times. Record highest pressure reading attained each time.
4. a. **If pressure readings are between 1150 and 1250 psi (7932-8621 kPa),** the pump is within specifications, If the **pump** tests OK, but system pressure was low (as tested under "Power Steering System Pressure Test". see "Index"), proceed to "Booster Cylinder Test", see "Index".
   b. **If pressure readings are between 1150-1250 psi (7932-8621 kPa), but are not within a 50 psi (345 kPa) range,** the Power Steering pump flow control valve is sticking or pump hydraulic system is dirty.
   c. **If pressure readings are constant, but below 1000 psi (6897 kPa),** replace Power Steering pump.

Power Steering Component Repair

Cable Guide Tube

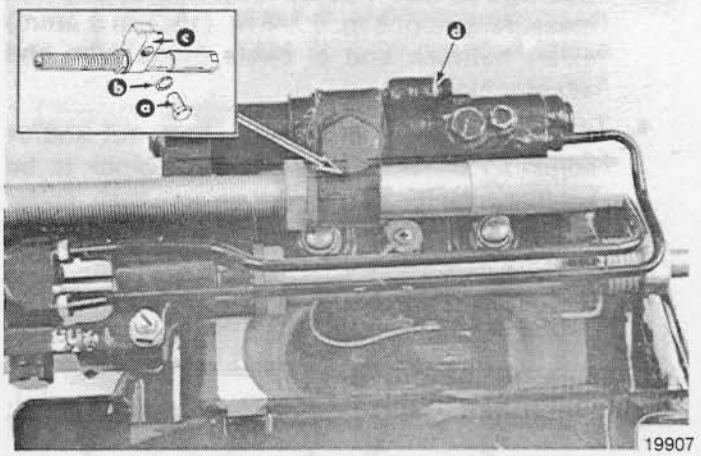
REMOVAL and DISASSEMBLY

1. Remove steering cable and Power Steering fluid hoses.



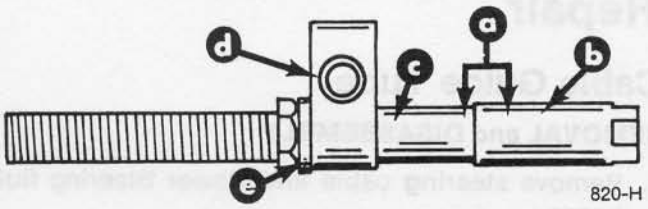
a - Steering Cable
b - Locking Sleeve
c - Cotter Pins
d - Cable Coupler Nut
e - Clevis Pin
f - Power Steering Fluid Hoses - Remove and Plug

2. • Loosen adaptor block nut.
   • Tap adaptor nut with hammer to loosen adaptor block.
   • Remove nut and washer; then, remove adaptor block.



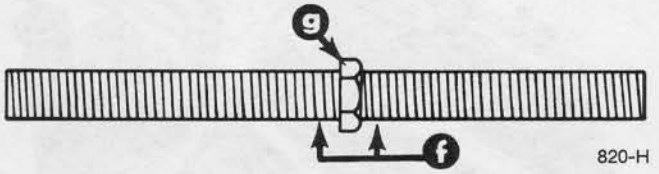
a - Adaptor Block Nut
b - Washer
c - Adaptor Block
d - Control Valve

3. Remove components shown from cable guide tube.



820-H

a - Apply Heat (from Torch Lamp, Etc.) to this Area to Breakdown Loctite
b - Adjusting Sleeve - Remove After Heated
c - Sleeve
d - Adaptor Block
e - Washer
Remove

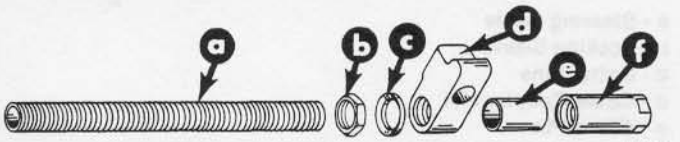


820-H

f - Apply Heat (from Torch Lamp, Etc.) to this Area to Breakdown Loctite
g - Nut - Remove After Heated

REASSEMBLY and INSTALLATION

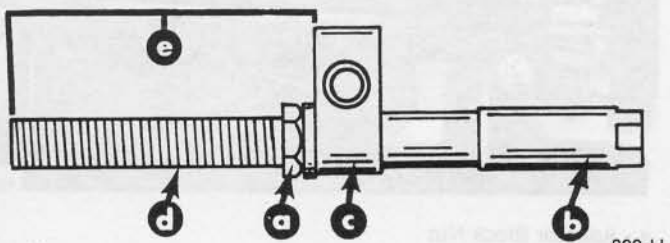
1. Install components shown on cable guide tube.



820-H

a - Cable Guide Tube
b - Nut - Thread Midway onto Tube
c - Washer - Concave Side Toward Nut
d - Adaptor Block
e - Sleeve
f - Adjusting Sleeve

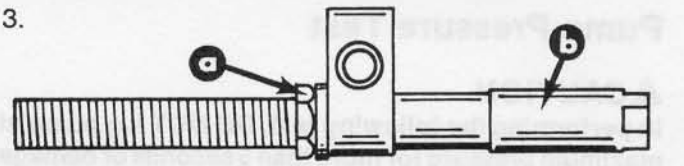
2. • Cable guide tube must be reassembled so that a measurement of 6 in. ± 1/8 in. (15.2cm ± 3mm) exists between end of cable guide tube and adaptor block.
   • To obtain proper dimension, turn nut and/or adjusting sleeve to allow adaptor block to be positioned at the correct dimension; then, finger tighten nut and sleeve against block



820-H

a - Nut
b - Adjusting Sleeve
c - Adaptor Block
d - Cable Guide Tube
e - 6 In ± 1/8 In. (15.2cm ± 3mm)

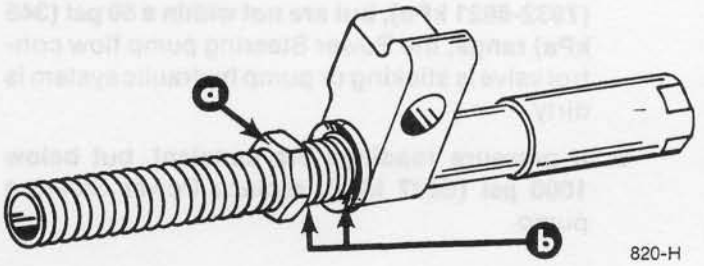
3.



820-H

a - Nut - Tighten Securely
b - Adjusting Sleeve - Torque to 30-40 Lbs. Ft. (41-54 N.m)

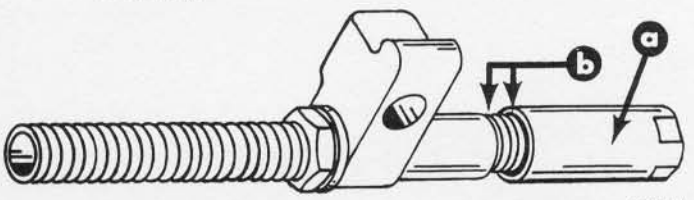
4. **⚠WARNING**
Loctite MUST BE applied to cable guide tube, threads to prevent tube from loosening during operation.
   • Back-off nut so that 3-4 guide tube threads are exposed.
   • Spray tube threads with Locquic Primer "T" 92-59327-1. After primer has dried (approximately 10 minutes), apply Loctite No. 35 92-59328-1 to threads.
   • Retighten nut against adaptor block.



820-H

a - Nut
b - Apply Locquic Primer "T" and Loctite No. 35 to Threads - See Instructions Above

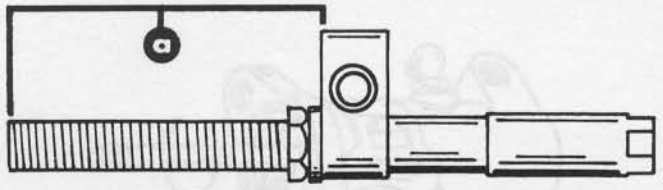
5. **⚠WARNING**
Loctite MUST BE applied to cable guide tube threads to prevent tube from loosening during operation.
   • Back-off adjusting sleeve so that 5-6 guide tube threads are exposed.
   • Spray tube threads with Locquic Primer "T" 92-59327-1. After primer has dried (apprroximately 10 minutes), apply Loctite No. 35 92-59328-1 to threads.
   • Retorque adjusting sleeve to 30-40 lbs. ft. (41-54 N.m).



820-H

a - Adjusting Sleeve
b - Apply Locquic Primer "T" and Loctite No. 35 to Threads - See Instructions Above

6. Recheck dimension between end of cable guide tube and adaptor block.



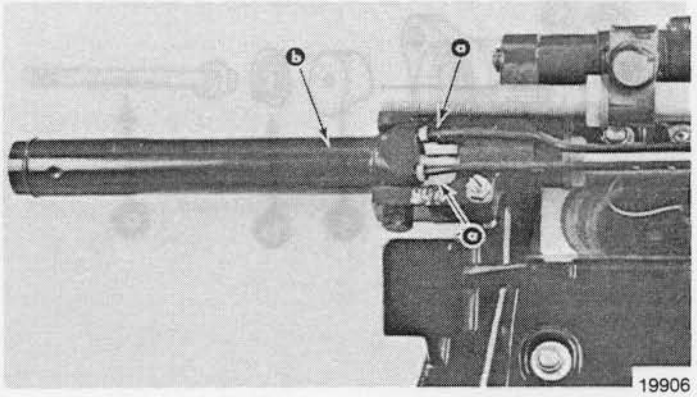
820-H

a - MUST BE 6 In. ± 1/8 In. (15.2cm ± 3mm)

Control Valve

REMOVAL

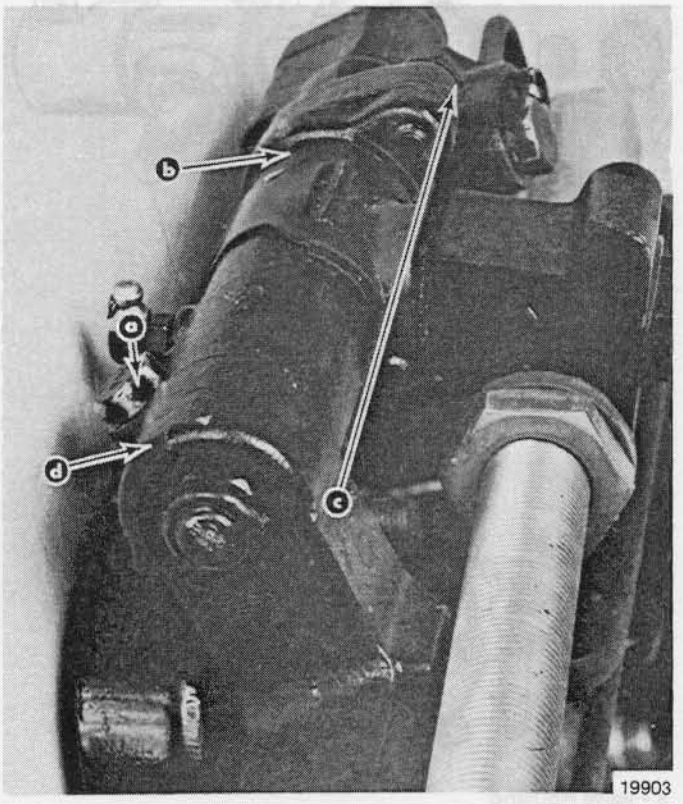
1. Remove steering cable and Power Steering pump fluid hoses.
2. Remove metal tubes from booster cylinder.



19906

a - Metal Tubes
b - Booster Cylinder

3. • Loosen clamping screw and remove control valve.
   • Remove metal tubes from control valve.

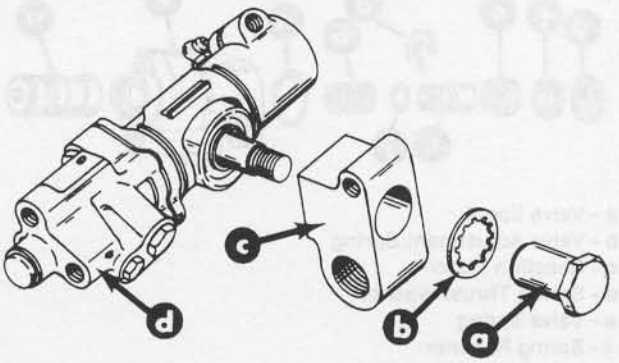


19903

a - Clamping Screw And Washer
b - Control Valve
c - Slide to Remove
d - Mounting Bracket

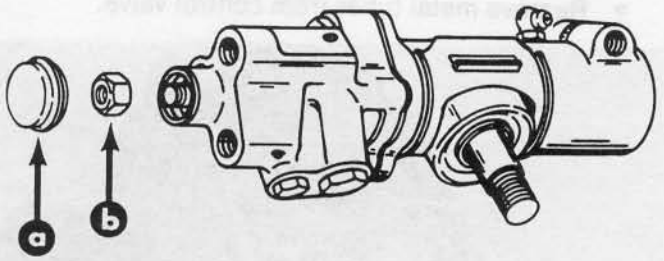
DISASSEMBLY

1. • Loosen adaptor block nut.
   • Tap adaptor nut with hammer to loosen block.
   • Remove nut, washer and adaptor block.



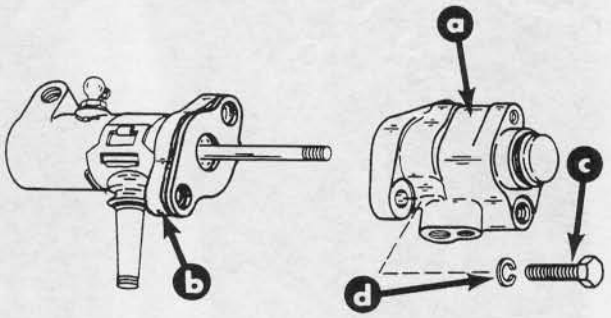
a - Adaptor Block Nut
b - Washer
c - Adaptor Block
d - Control Valve

2. Remove dust cover and adjusting nut.



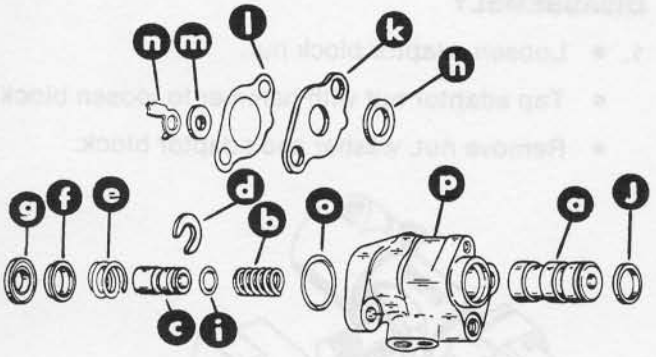
a - Dust Cover
b - Adjusting Nut

3. Separate valve housing from adaptor.



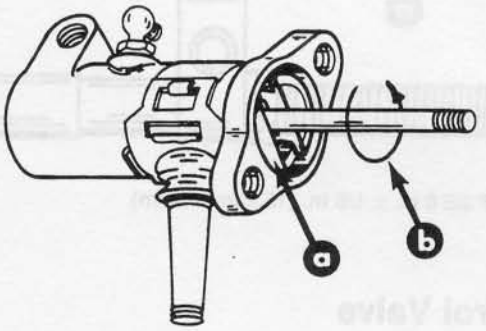
a - Valve Housing
b - Adaptor
c - Screws (2)
d - Lockwashers (2)

4. Remove components shown.



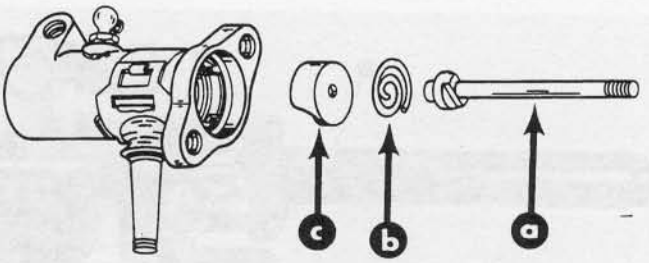
a - Valve Spool
b - Valve Adjustment Spring
c - Reaction Spool
d - Spring Thrust Washer
e - Valve Spring
f - Spring Retainer
g - Annulus Seal
h - Large ID Washer
i - Reaction Spool "O" Ring
j - Valve Spool "V" Block Seal
k - Annulus Spacer
l - Gasket
m - Small Washer
n - Plug to Sleeve Key
o - "O" Ring

5. Carefully (so as not to nick the top surface) turn adjusting plug out of sleeve.



a - Adjusting Plug
b - Turn Counterclockwise

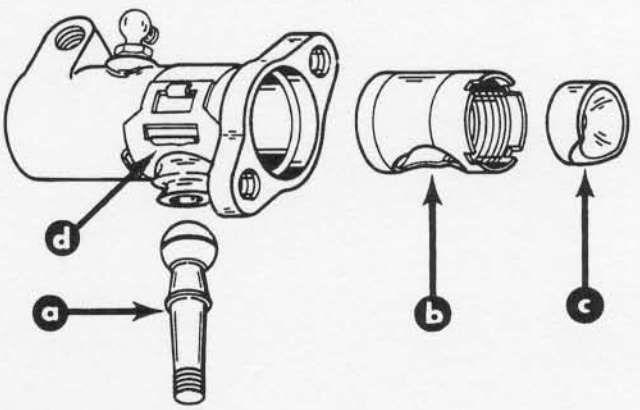
6. Remove components shown.



a - Valve Shaft
b - Ball Seat Spring
c - Upper Ball Seat

7. Remove sleeve bearing and lower ball seat.

NOTE: Metal band around rubber boot is not available as a replacement part and, therefore, should not be removed from control valve.

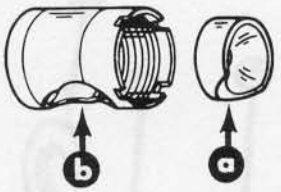


a - Ball Stud - Pull Up into Rubber Boot
b - Sleeve Bearing — Remove
c - Lower Ball Seat — Remove
d - Metal Band - Do Not Remove

8. Clean and inspect metal parts. If any metal part shows signs of wear, replace control valve assembly.

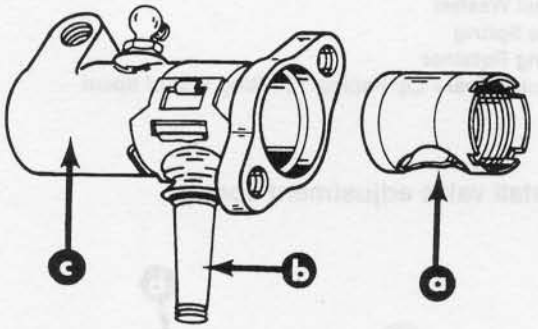
REASSEMBLY

1. Install lower ball seat into sleeve bearing.



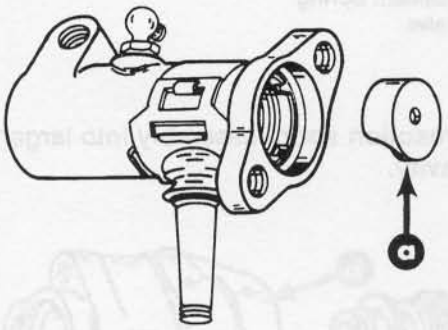
a - Lower Ball Seat
b - Sleeve Bearing

2. Install sleeve bearing (with lower ball seat).



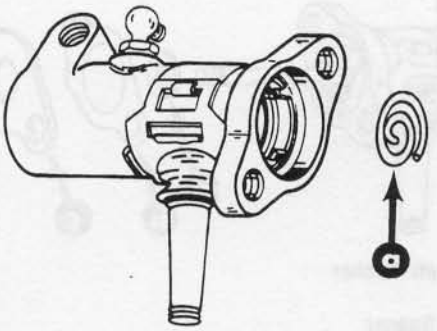
a - Sleeve Bearing (and Lower Ball Seat)
b - Ball Stud - Pull Up into Rubber Boot
c - Adaptor Housing

3. Position ball stud in sleeve bearing.
4. Install upper ball seat.



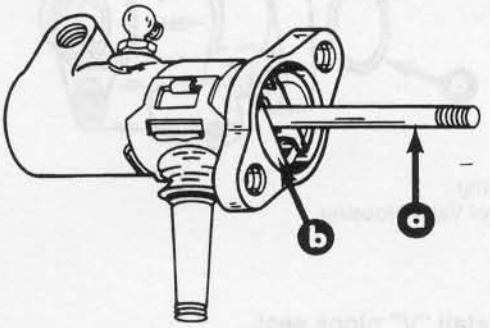
a - Upper Ball Seat

5. Install ball seat spring.



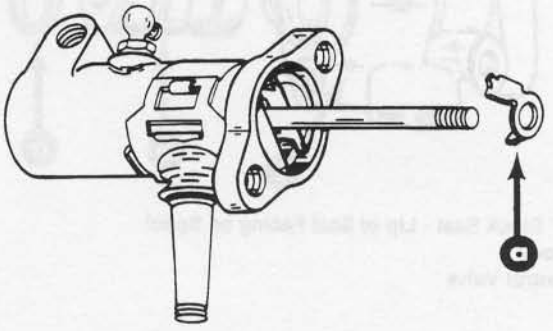
a - Ball Seat Spring - Small Coil In

6. • Insert valve shaft into adjuster plug.
   • Screw adjusting plug into sleeve until tight; then, back off plug until slot lines up with notches in sleeve.



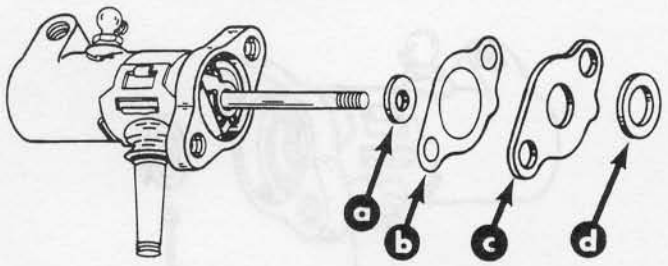
a - Valve Shaft
b - Adjusting Plug

7. Install key.



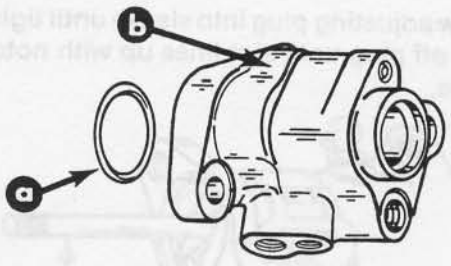
a - Key - Tangs on Key to Fit into Notches in Plug

8. Install components shown.



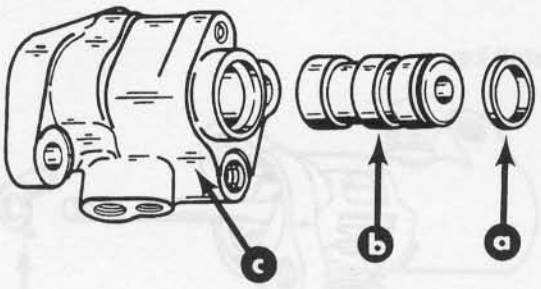
a - Valve Shaft Washer
b - Gasket
c - Annulus Spacer
d - Large ID Washer

9. Install "O" ring in control valve housing.



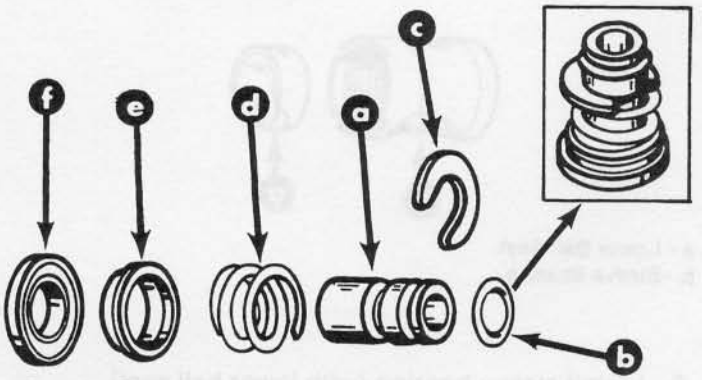
a - "O" Ring
b - Control Valve Housing

10. • Install "V" block seal.
    • Insert valve spool into adjusting nut end of control valve.



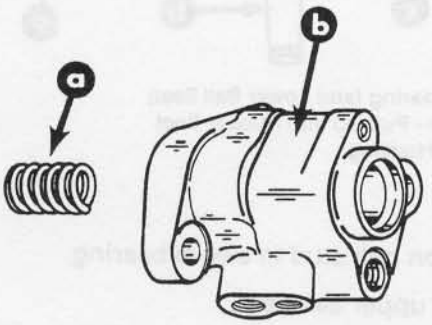
a - "V" Block Seal - Lip of Seal Facing on Spool
b - Spool
c - Control Valve

11. Assemble reaction spool.



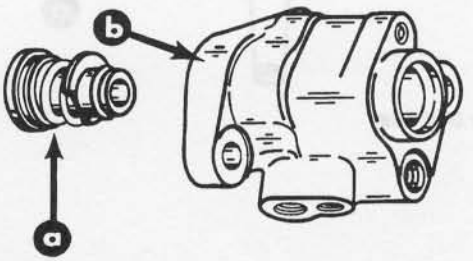
a - Reaction Spool
b - "O" Ring
c - Thrust Washer
d - Valve Spring
e - Spring Retainer
f - Annulus Seal - Lip Facing "O" Ring End of Spool

12. Install valve adjustment spring.



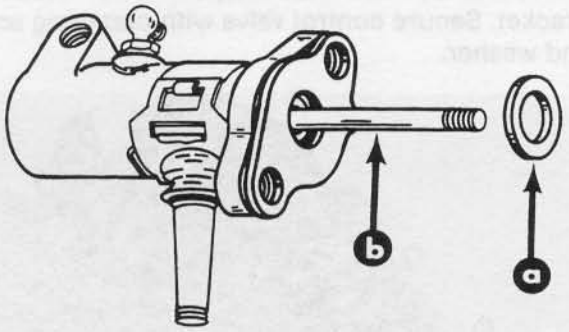
a - Valve Adjusment Spring
b - Control Valve

13. Install reaction spool assembly into larger control valve cavity.



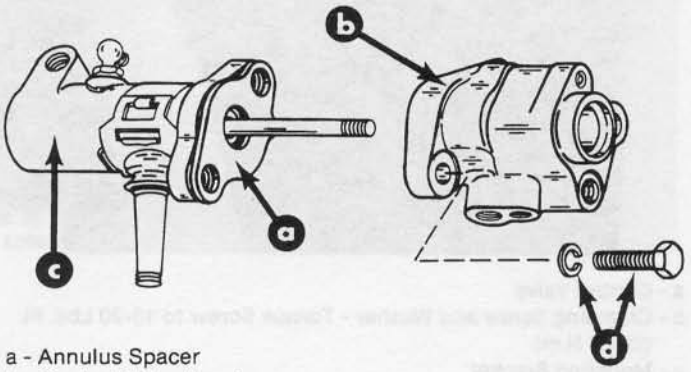
a - Reaction Spool Assembly
b - Control Valve - Large Cavity

14. Install large ID washer.



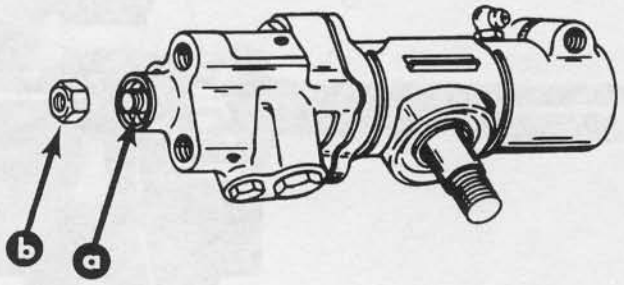
a - Large ID Washer
b - Valve Shaft

15. • Match annulus spacer to control valve housing.
    • Secure adaptor housing to control valve housing.



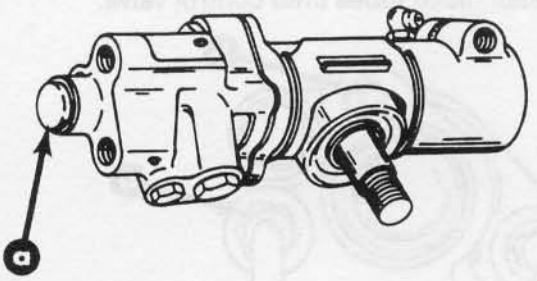
a - Annulus Spacer
b - Control Valve Housing
c - Adaptor Housing
d - Screws and Washers (2 Each) - Torque Screws to 20-30 Lbs. Ft. (27-41 N.m)

16. Depress valve spool. Install locknut; thread about 4 turns.



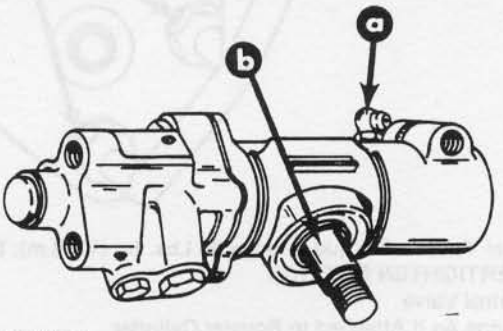
a - Valve Shaft
b - Locknut

17. Install dust cover.



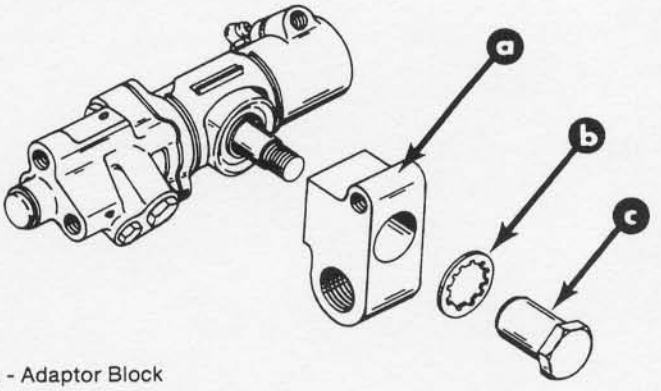
a - Dust Cover

18. Lubricate control valve with Quicksilver 2-4-C Multi-Lube until lubricant appears around rubber boot.



a - Grease Fitting
b - Rubber Boot

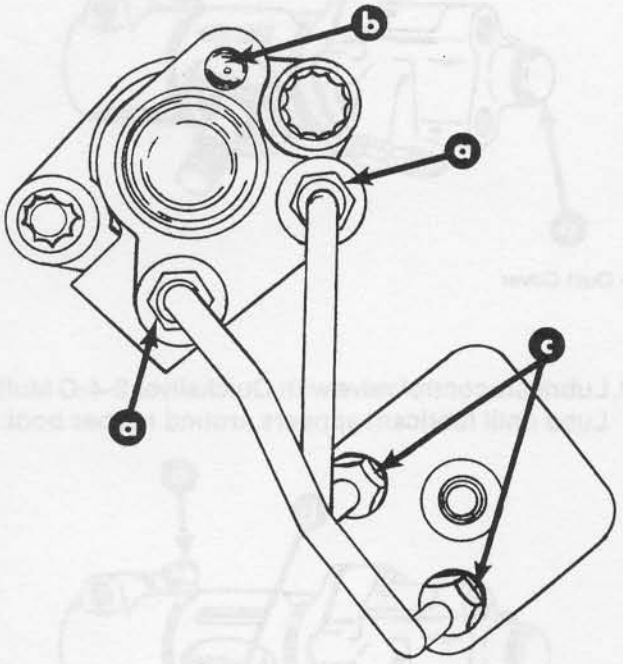
19. Install adaptor block.



a - Adaptor Block
b - Internal Lockwasher
c - Nut - Torque to 30-40 Lbs. Ft. (41-54 N.m)

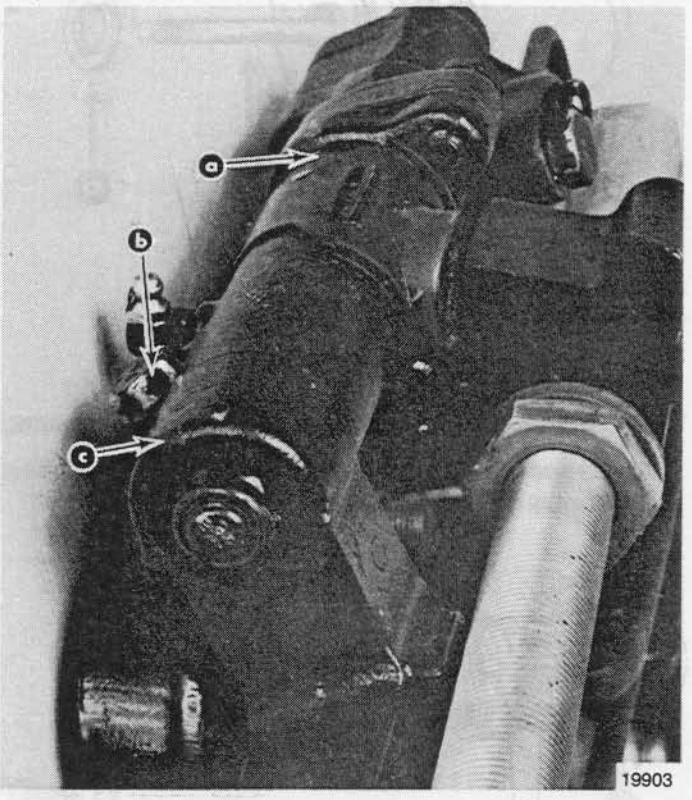
INSTALLATION

1. Install metal tubes onto control valve.



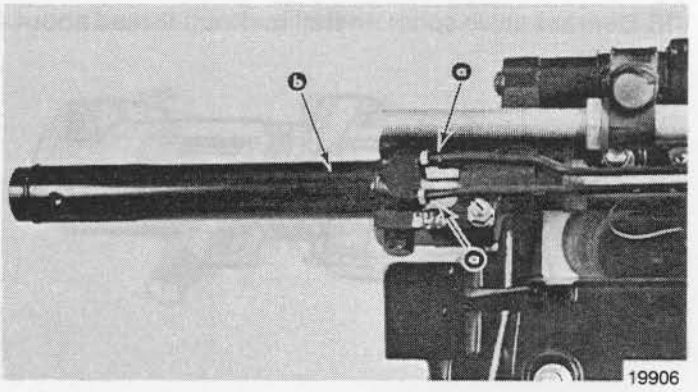
a - Metal Tubes - Torque Fittings 95 Lbs. In. (11 N.m); DO NOT OVERTIGHTEN FITTINGS
b - Control Valve
c - Fittings As If Attached to Booster Cylinder

2. Guiding metal tube fittings into booster cylinder ports, slide control valve into position on mounting bracket. Secure control valve with clamping screw and washer.



a - Control Valve
b - Clamping Screw and Washer - Torque Screw to 15-20 Lbs. Ft. (20-27 N.m)
c - Mounting Bracket

3. Secure metal tubes to booster cylinder.



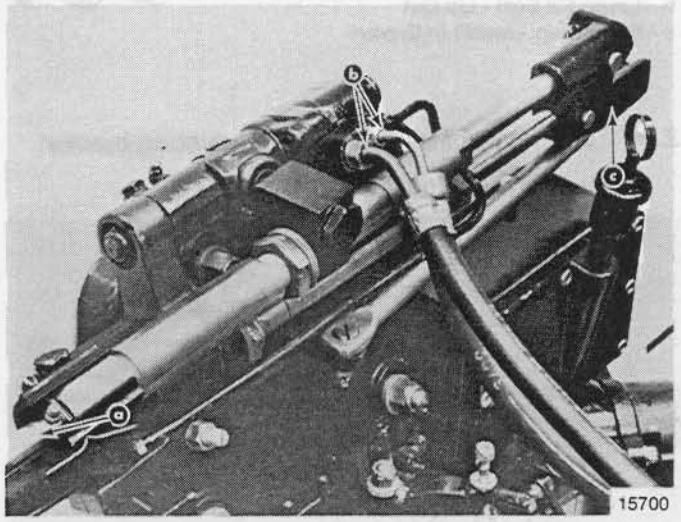
a - Metal Tubes - Torque Fittings to 95 Lbs. In. (11 N.m); DO NOT OVERTIGHTEN FITTINGS
b - Booster Cylinder

4. Install Power Steering pump fluid hoses and steering cable.

Booster Cylinder

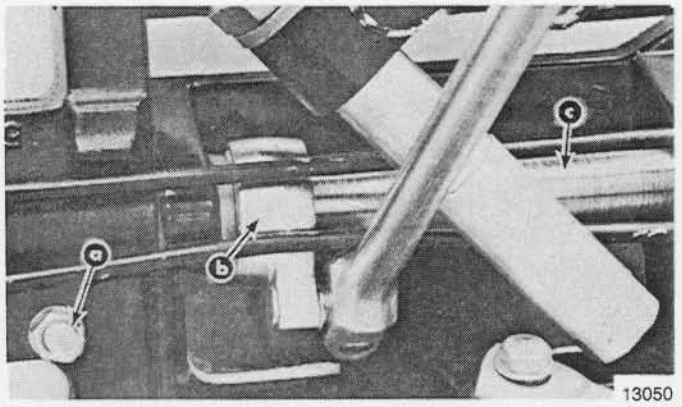
REMOVAL

1. • Remove steering cable.
   • Remove Power Steering pump fluid hoses.
   • Remove cable end adaptor.



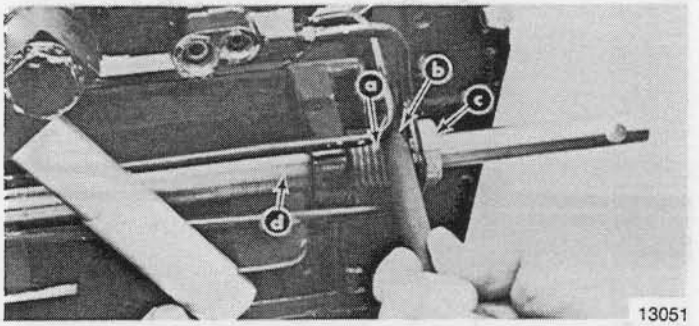
a - Steering Cable
b - Power Steering Pump Fluid Hoses
c - Cable End Adaptor

2. • Loosen Power Steering unit set screw.
   • Loosen mounting tube jam nut.



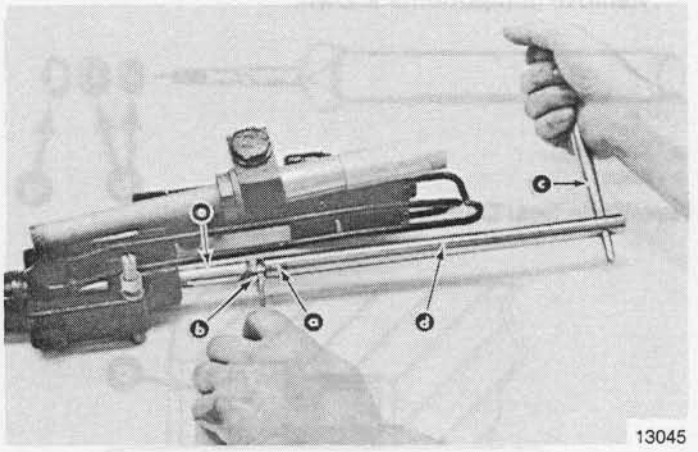
a - Set Screw
b - Crow's Foot Tool 91-89035
c - Mounting Tube

3. • Place a 1/8 In. I.D. tube over locking spring end.
   • Lift spring slightly, using tube, to release spring tension on mounting tube and remove nut from end of tube.



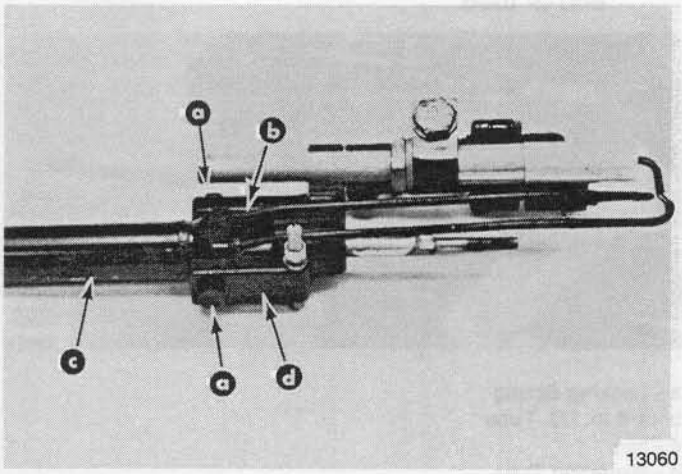
a - Locking Spring
b - 1/8 In. I.D. Tube
c - Nut
d - Mounting Tube

4. • Remove mounting tube.
   • Remove Power Steering unit.
5. To remove extension rod, from piston rod, heat area 1/2 in. (13mm) from point where piston rod and extension rod are joined. Unthread extension rod from piston rod.



a - Heat this Area
b - 7/16 In. Wrench
c - Brass Rod (or Suitable Rod)
d - Extension Rod
e - Piston Rod

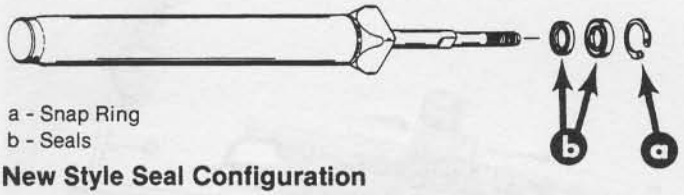
6. • Remove metal tubes from booster cylinder.
   • Separate booster cylinder from mounting bracket.



a - Bolts and Lockwashers - Remove
b - Metal Tubes - Remove
c - Booster Cylinder
d - Mounting Bracket

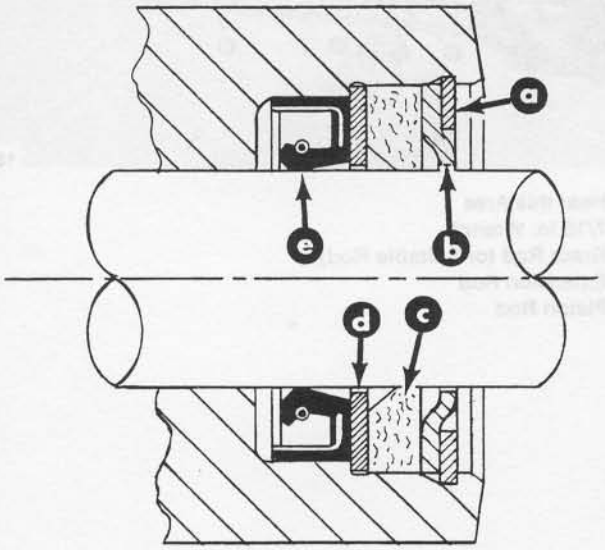
7. NOTE: Seal kit 25-58224A1 is a replacement for cylinders with either seal configuration shown below.

   Remove components shown.



a - Snap Ring
b - Seals

New Style Seal Configuration

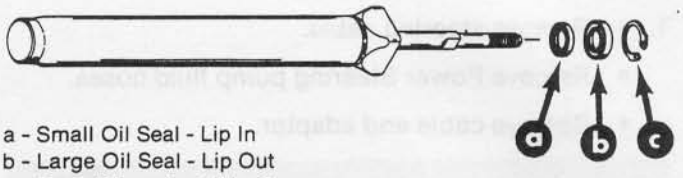


a - Snap Ring
b - Scraper
c - Scraper Element
d - Backing Washer
e - Seal

Old Style Seal Configuration

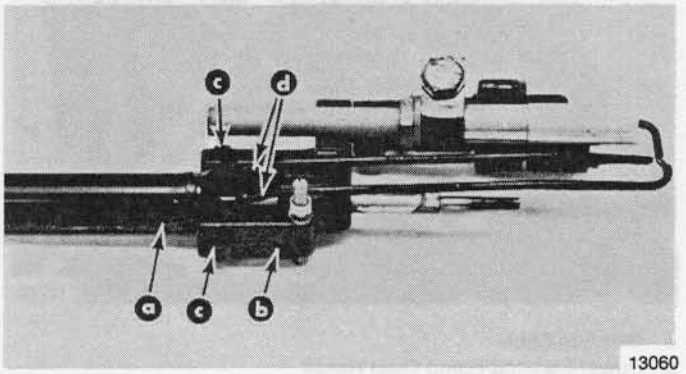
INSTALLATION

1. Install components shown.



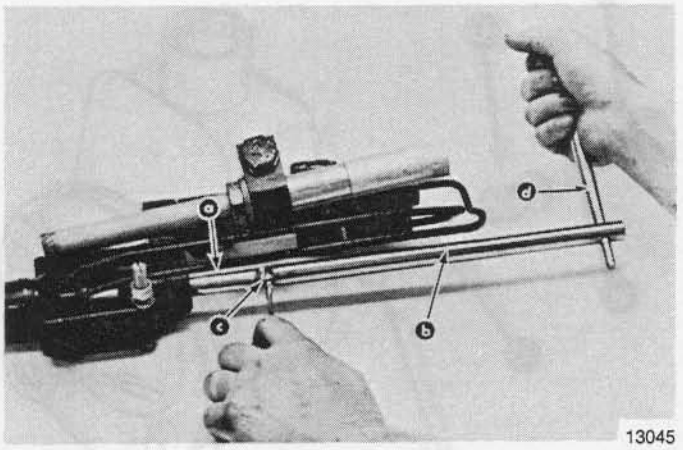
a - Small Oil Seal - Lip In
b - Large Oil Seal - Lip Out
c - Snap Ring - Install In Groove

2. • Secure booster cylinder to mounting bracket.
   • Install metal tubes.



a - Booster Cylinder
b - Mounting Bracket
c - Pivot Bolts and Lockwashers - Torque Bolts to 25-35 Lbs. Ft. (34-47 N.m)
d - Metal Tubes - Torque Fittings to 95 Lbs. In. (11 N.m)

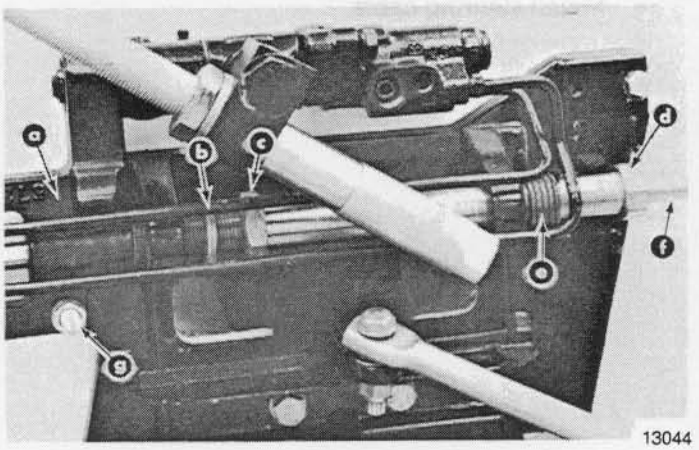
3. NOTE: Due to certain engine compartment restrictions, it may be necessary to secure extension rod to piston rod AFTER Power Steering unit is positioned on inner transom plate.
   - Clean internal extension rod threads with lacquer thinner.
   - Clean piston rod threads with a wire brush.
   - Spray piston rod threads with Locquic Primer "T". Allow primer to dry (approximately 10 minutes).
   - Apply a few drops of Loctite No. 35 to piston rod threads.
   - Thread extension rod onto piston rod.
   - Wipe off any excess Loctite.



13045

a - Piston Rod
b - Extension Rod - Torque to 12-15 Lbs. Ft. (16-20 N.m)
c - 7/16 In. Wrench
d - Brass Rod

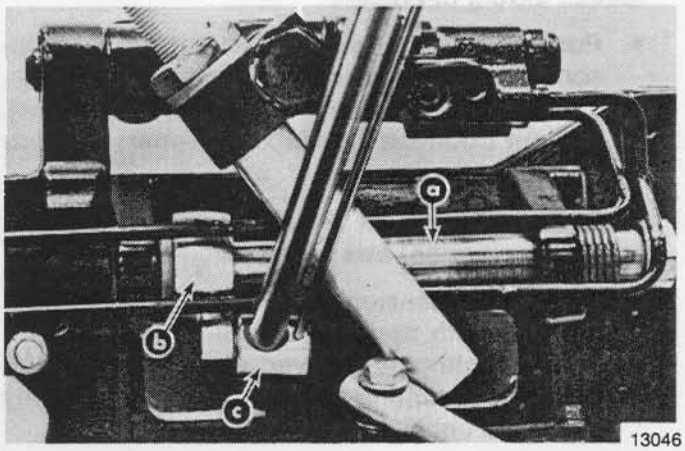
4. **⚠WARNING**
   Mounting tube jam nut and washer MUST BE installed correctly, or Power Steering unit may loosen during operation.
   - Position Power Steering unit thru inner transom plate starboard steering mounting boss, concave washer (concave side facing jam nut), jam nut (rounded side facing washer) and thru port mounting boss.
   - Position spring on mounting tube. Place 90° tang (on spring) away from nut on end of tube.
   - Lubricate extension rod and inside of mounting tube with Special Lubricant 101 and position mounting tube over extension rod and thru port mounting boss. Thread jam nut fully onto tube until it bottoms-out.
   - Thread mounting tube into Power Steering unit until jam nut bottoms against transom plate starboard steering mounting boss.
   - Rotate Power Steering unit until it bottoms against inner transom plate; then, turn adjusting screw in finger-tight against transom plate and secure with locknut.



13044

a - Power Steering Unit
b - Concave Washer - Concave Side Facing Jam Nut
c - Jam Nut - Rounded Side Facing Concave Washer
d - Mounting Tube and Nut
e - Locking Spring
f - Extension Rod
g - Set Screw and Locknut

5. • Torque nut on end of mounting tube to 10 lbs. ft. (14 N.m).
   • Torque jam nut to 30-40 lbs. ft. (41-54 N.m).



13046

a - Mounting Tube
b - Crow's Foot Tool 91-89035 - Use to Torque Jam Nut to 30-40 Lbs. Ft. (41-54 N.m)
c - Torque Wrench

6. • Install cable end adaptor.
   • Install Power Steering pump fluid hoses.
   • Install steering cable.

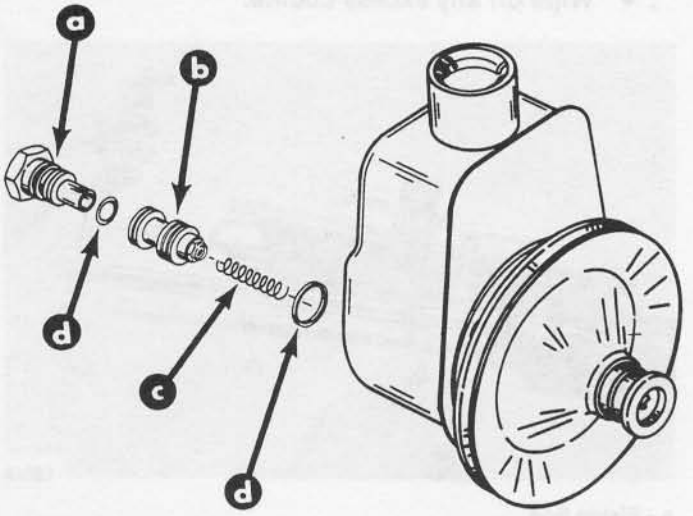
Power Steering Pump

REMOVAL

1. Disconnect hoses at pump. Cap hose and fittings.
2. Loosen pump bolts at engine to remove pump belt.
3. Remove bracket from pump.

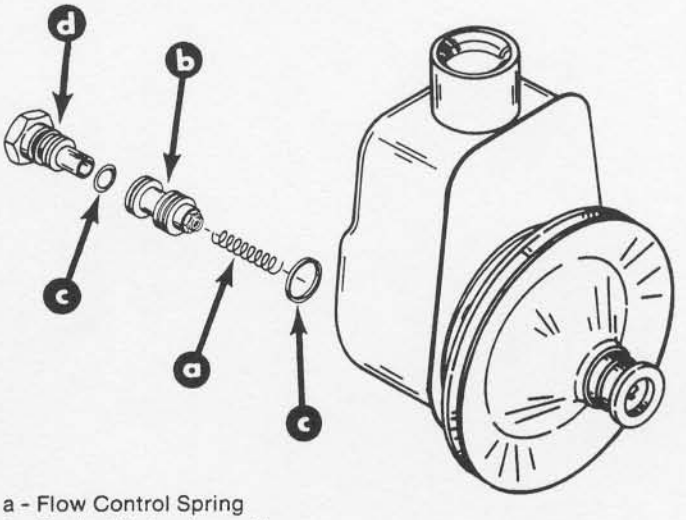
FLOW CONTROL VALVE SERVICING

1. Remove fill cap and drain fluid from pump.
2. Remove components shown.



a - Fitting Assembly
b - Control Valve Assembly
c - Flow Control Spring
d - "O" Rings and Discard

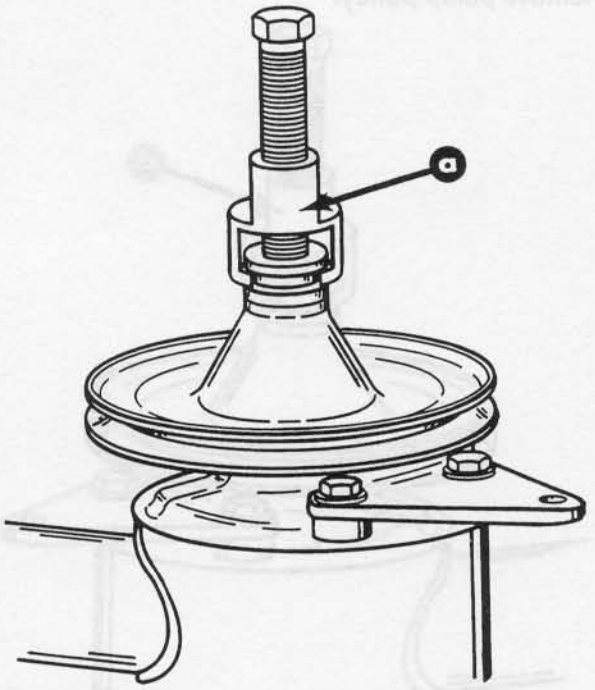
3. Inspect control valve assembly and fitting assembly.
4. Install components shown.



a - Flow Control Spring
b - Control Valve Assembly
c - New "O" Rings
d - Fitting Assembly - Torque to 35 Lbs. Ft. (47 N.m)

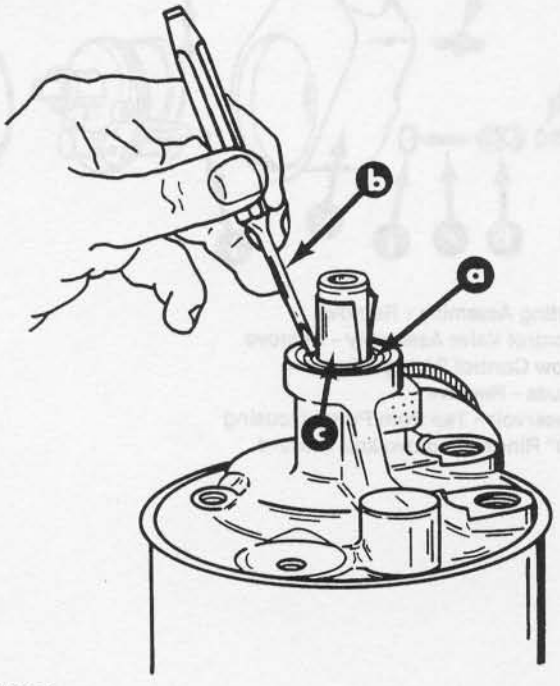
PUMP SHAFT OIL SEAL REPLACEMENT

1. Remove pump pulley.



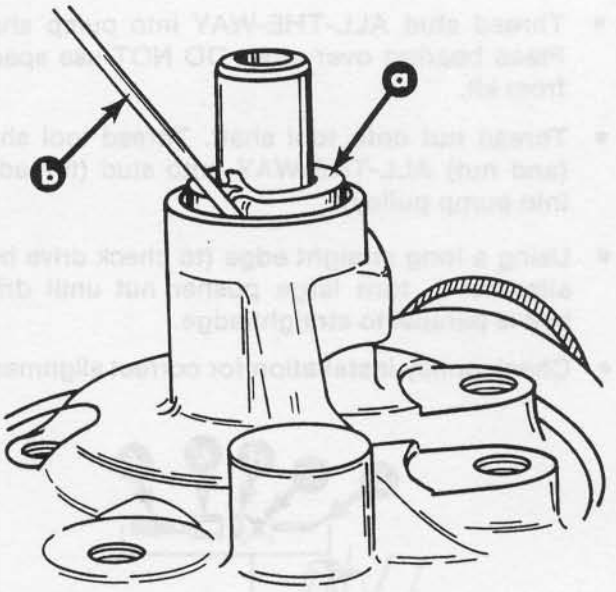
a - Kent Moore Pulley Removal Tool (J-25034 or J-21239-1

2. Push a .005 in. (0.13mm) shim stock past oil seal until it bottoms in pump body. (Approximately 2-1/2 in. [64mm] long)
3. Cut seal and tear metal body approximately 1 in. (25mm).



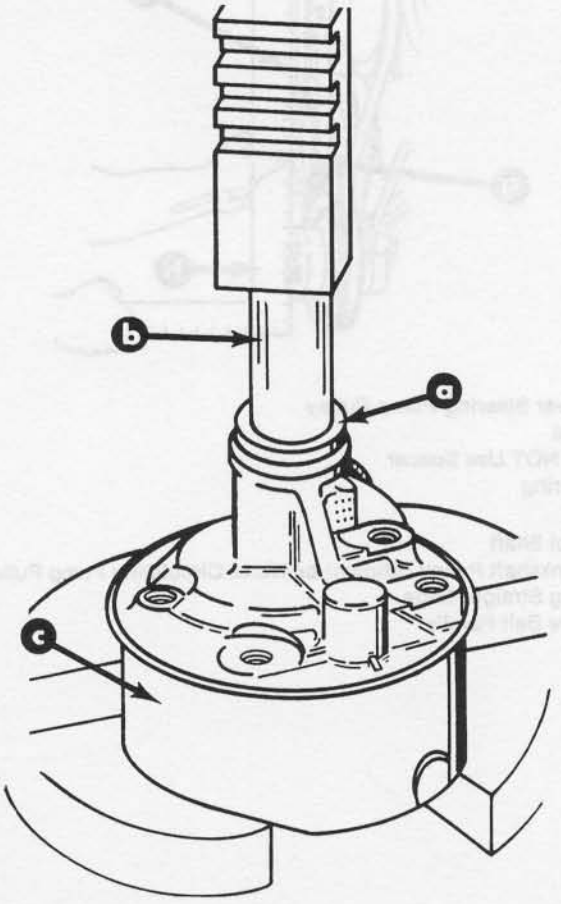
a - Oil Seal
b - Chisel - To Cut Seal
c - .005 In. (0.13mm) Shim Stock

4. Remove oil seal.
   Remove shim stock.



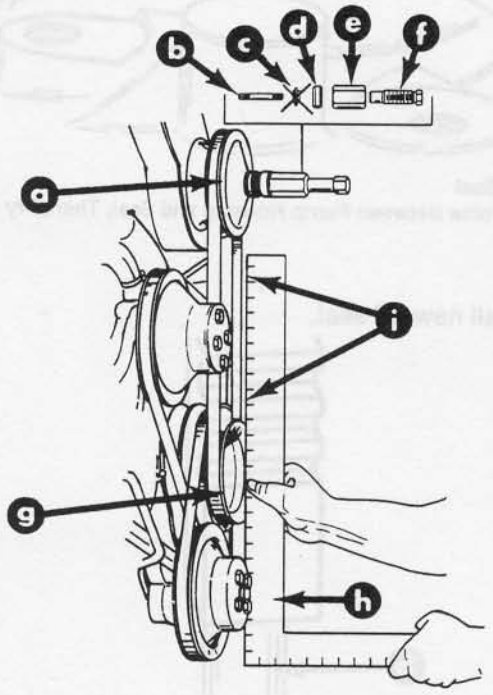
a - Torn Seal
b - Awl-Force Between Pump Housing and Seal; Then, Pry Out

5. Install new oil seal.



a - New Oil Seal - Metal Side Up
b - 1 In. Socket
c - Pump Reservoir - Properly Support So Reservoir Back Does Not Distort

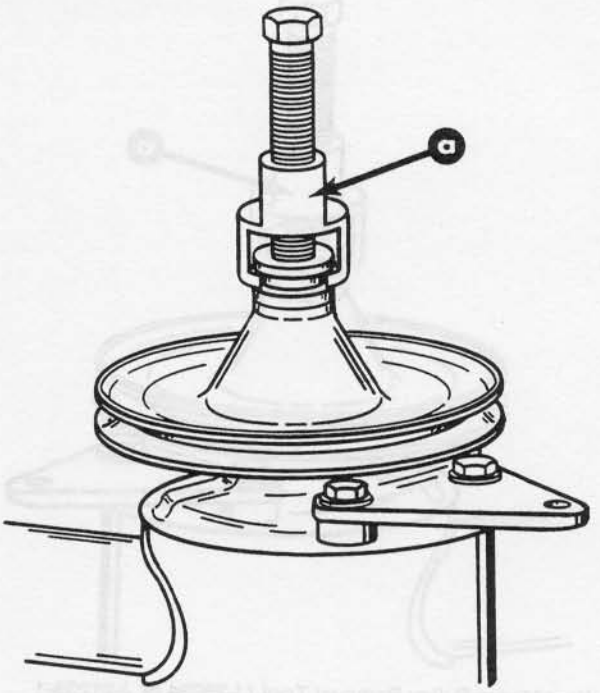
6. Install pulley, as follows, using Pulley Pusher Assembly 91-93656A1, and a long straight edge:
   - Place pulley on pump shaft.
   - Thread stud ALL-THE-WAY into pump shaft. Place bearing over stud. DO NOT use spacer from kit.
   - Thread nut onto tool shaft. Thread tool shaft (and nut) ALL-THE-WAY onto stud (threaded into pump pulley).
   - Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
   - Check pulley installation for correct alignment.



a - Power Steering Pump Pulley
b - Stud
c - DO NOT Use Spacer
d - Bearing
e - Nut
f - Tool Shaft
g - Crankshaft Pulley (Shown) or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

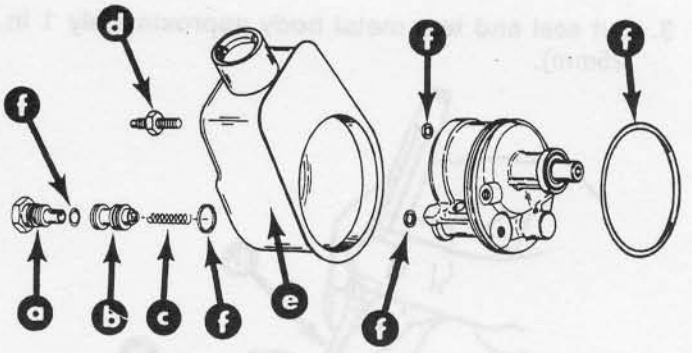
DISASSEMBLY

1. Drain fluid from pump.
2. Remove pump pulley.



a - Kent Moore Pulley Removal Tool (J-25034 or J-21239-1)

3. Remove reservoir.



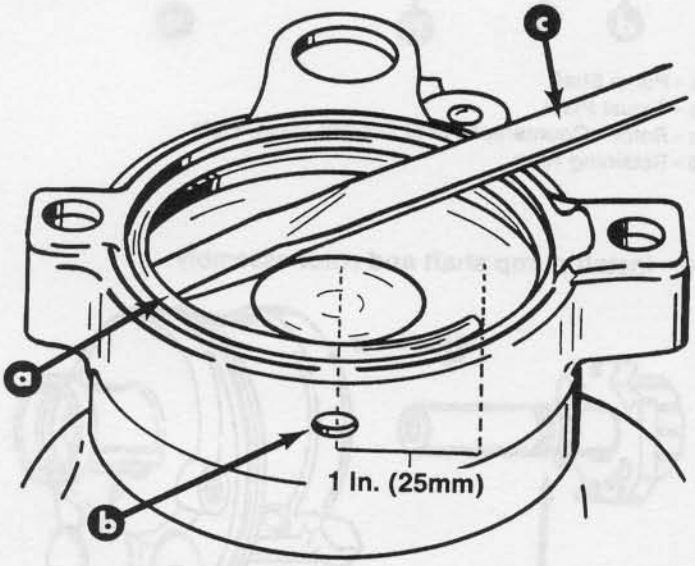
a - Fitting Assembly - Remove
b - Control Valve Assembly - Remove
c - Flow Control Spring - Remove
d - Studs - Remove
e - Reservoir - Tap from Pump Housing
f - "O" Rings - Remove and Discard

4.

⚠WARNING

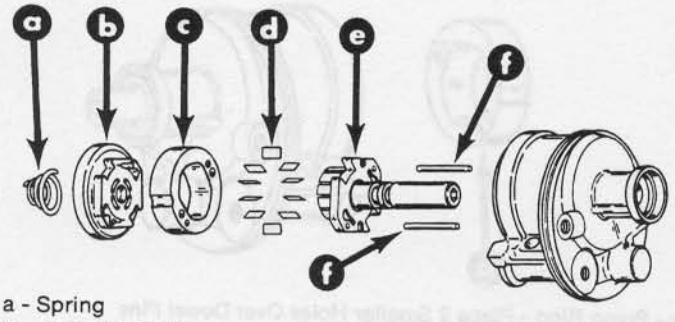
Take necessary safety precautions when removing retaining ring. Ring tension may cause ring to release from groove forcefully during removal.

Remove retaining ring and end plate.



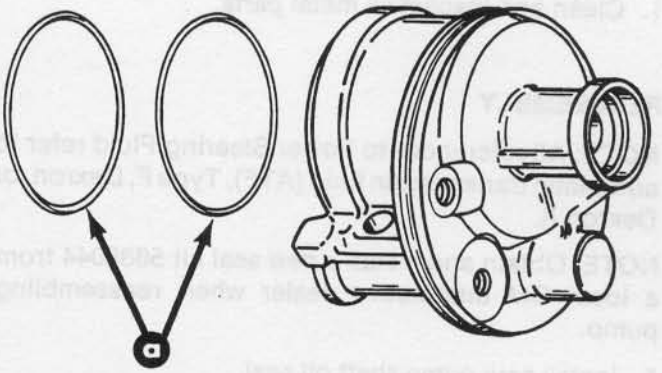
a - Retaining Ring - Position So That Ring End Is 1 In. (25mm) from End of Hole in Housing
b - Hole - Insert into Awl in Housing to Push Ring from Recess
c - Screwdriver - Pry Ring from Pump Body

5. Remove pump components shown.



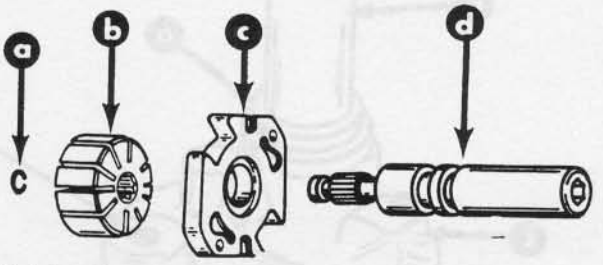
a - Spring
b - Pressure Plate
c - Pump Ring
d - Pump Vanes
e - Pump Shaft and Rotor Assembly
f - Dowel Pins

6. Remove and discard "O" rings from housing.



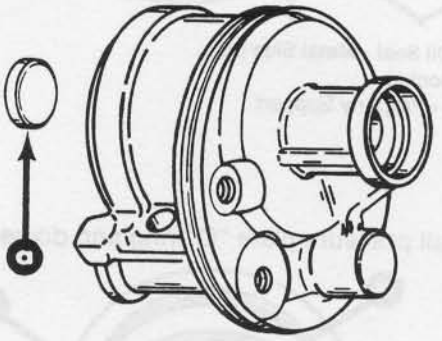
a - "O" Rings - Discard

7. Remove rotor and thrust plate.



a - Retaining Ring - Remove
b - Rotor
c - Thrust Plate
d - Pump Shaft

8. Remove magnet.



a - Magnet

CLEANING and INSPECTION

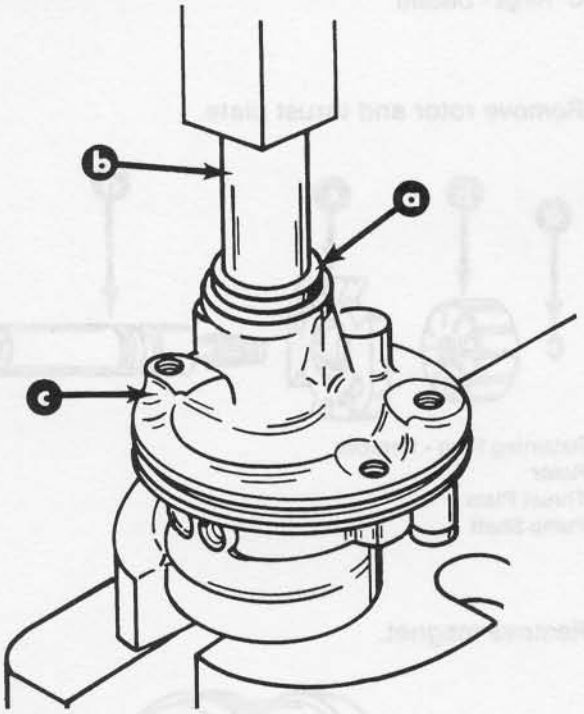
1. Clean and inspect all metal parts.

REASSEMBLY

NOTE: All references to Power Steering Fluid refer to automatic transmission fluid (ATF), Type F, Dexron, or Dexron II.

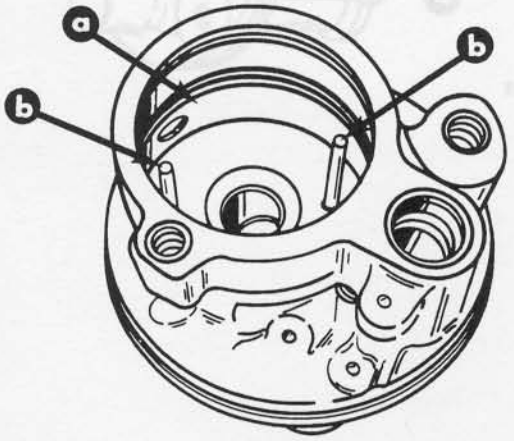
NOTE: Obtain and install a new seal kit 5688044 from a local GM automotive dealer when reassembling pump.

1. Install new pump shaft oil seal.



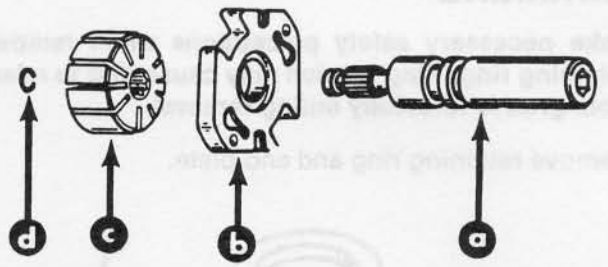
a - New Oil Seal - Metal Side Up
b - 1 In. Socket
c - Pump - Properly Support

2. Install pressure plate "O" ring and dowel pins.



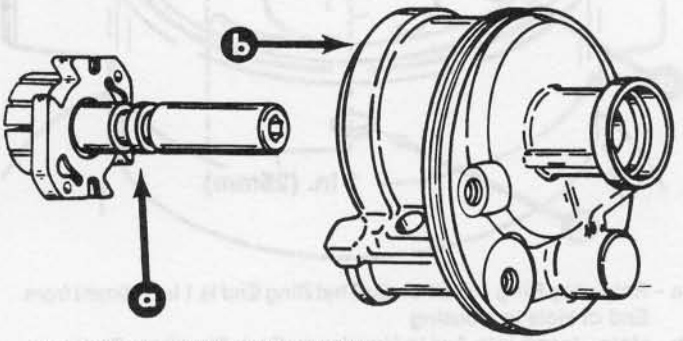
a - Pressure Plate "O" Ring - Lubricate with Power Steering Fluid; Place in Third Groove in Housing
b - Dowel Pins

3. Assemble pump shaft and rotor assembly.



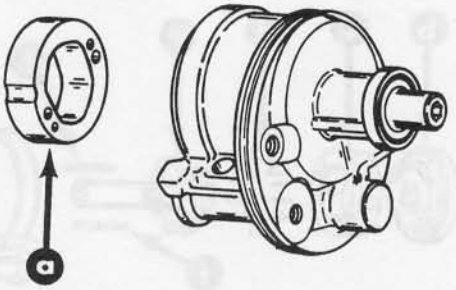
a - Pump Shaft
b - Thrust Plate
c - Rotor - Countersunk Side Toward Thrust Plate
d - Retaining Ring

4. Install pump shaft and rotor assembly.



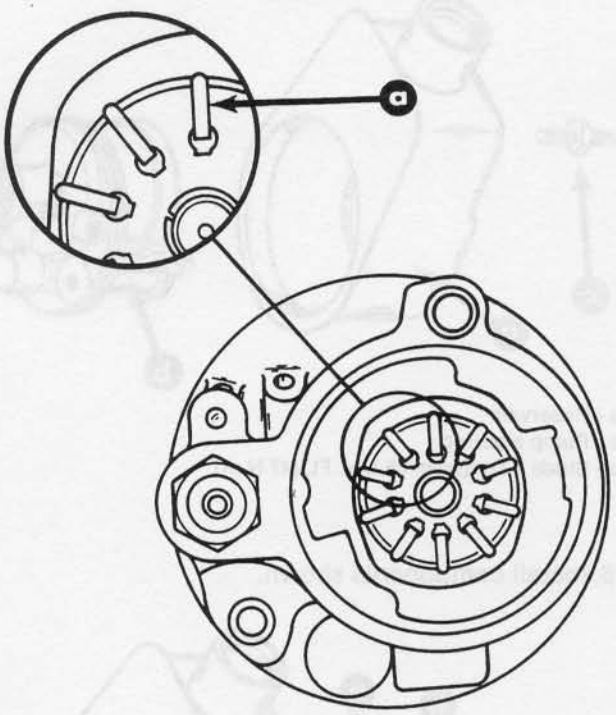
a - Pump Shaft and Rotor Assembly
b - Pump Housing

5. Install pump ring.



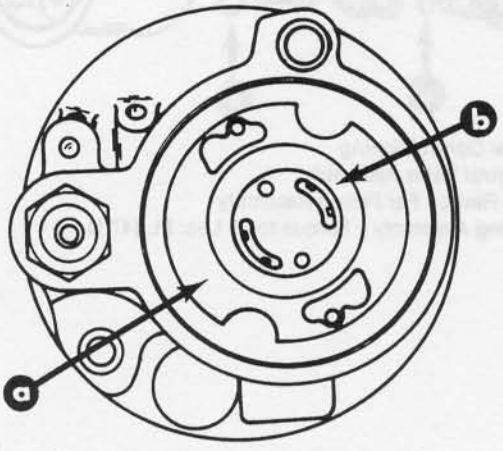
a - Pump Ring - Place 2 Smaller Holes Over Dowel Pins

6. Install vanes in rotor slots - Rounded edges toward pump ring. Vanes must slide freely.



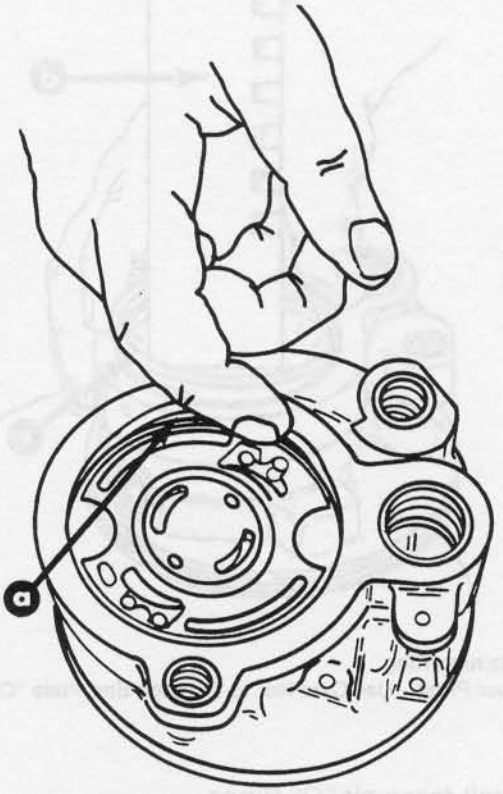
a - Vanes - Rounded Edges Toward Pump Ring

7. Install pressure plate.



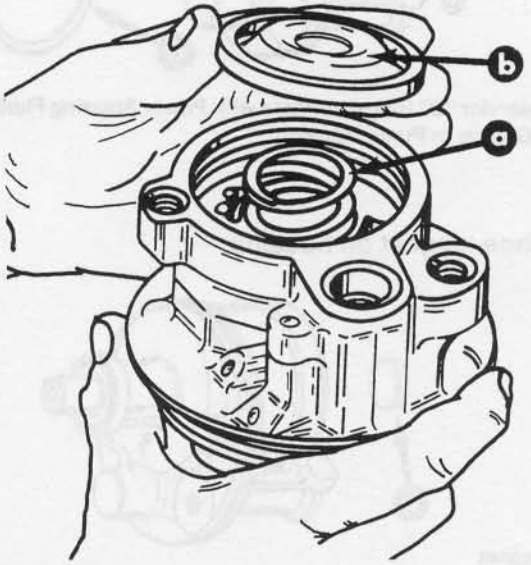
a - Pressure Plate
b - Spring Groove - Facing Up

8. Install end plate "O" ring.

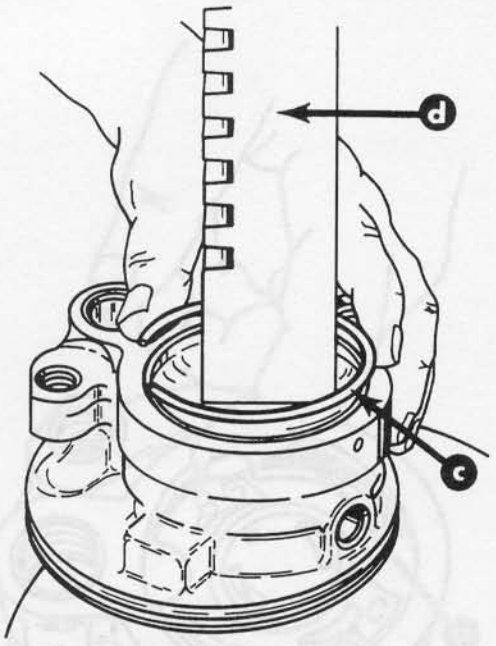


a - End Plate "O" Ring - Lubricate with Power Steering Fluid; Place in Second Groove in Housing

9. Install pressure plate spring, end plate and retaining ring.

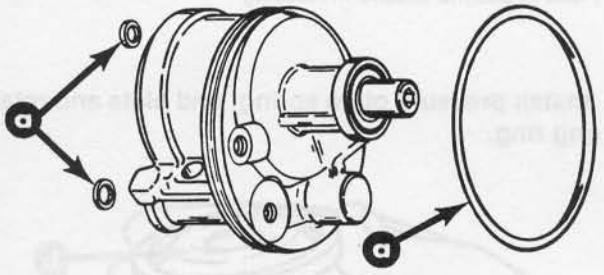


a - Pressure Plate Spring
b - End Plate



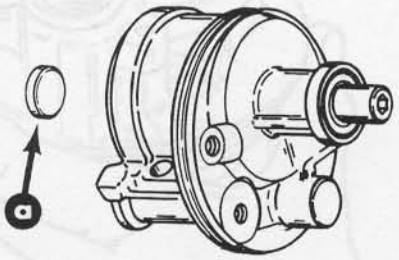
c - Retaining Ring
d - Arbor Press - Use Care Not to Damage End Plate "O" Ring

10. Install reservoir "O" Rings.



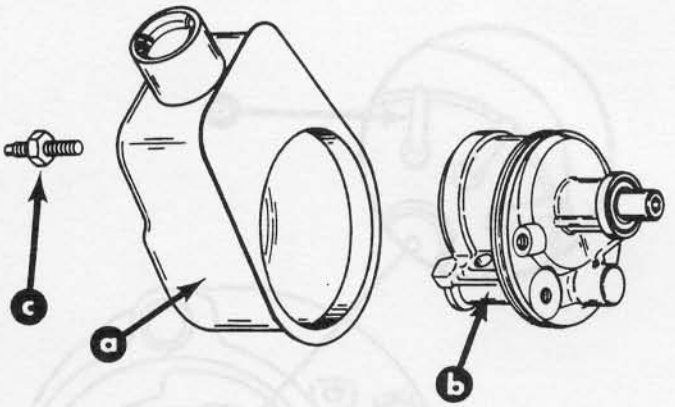
a - Reservior "O" Ring-Lubricate with Power Steering Fluid; Install in Groove in Pump Housing

11. Place magnet on housing.



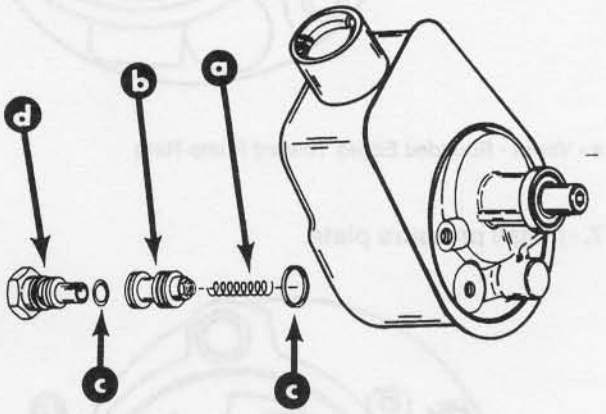
a - Magnet

12. Secure reservoir to pump housing.



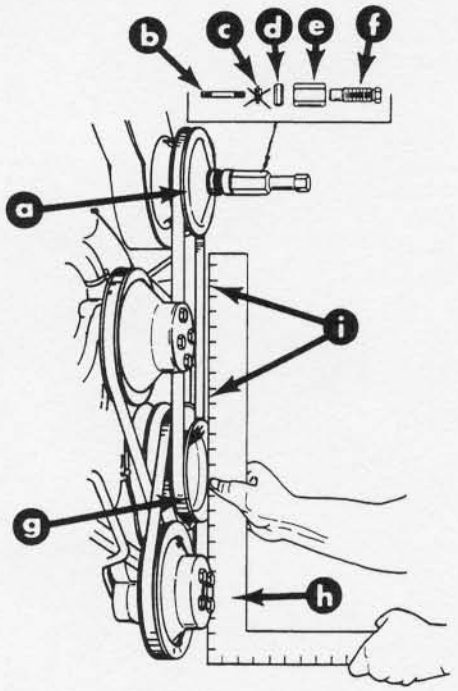
a - Reservoir
b - Pump Housing
c - Studs - Torque to 35 Lbs. Ft. (47 N.m)

13. Install components shown.



a - Flow Control Spring
b - Control Valve Assembly
c - "O" Rings - For Fitting Assembly
d - Fitting Assembly - Torque to 35 Lbs. Ft. (47 N.m)

14. Install pulley, as follows, using Pulley Pusher Assembly 91-93656A1, and a long straight edge:
    - Place pulley on pump shaft.
    - Thread stud ALL-THE-WAY into pump shaft. Place bearing over stud. DO NOT use spacer from kit.
    - Thread nut onto tool shaft. Thread tool shaft (and nut) ALL-THE-WAY onto stud (threaded into pump pulley).
    - Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
    - Check pulley installation for correct alignment.



a - Power Steering Pump Pulley
b - Stud
c - DO NOT Use Spacer
d - Bearing
e - Nut
f - Tool Shaft
g - Crankshaft Pulley (Shown) or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

INSTALLATION

1. Install mounting bracket on pump.
2. Secure Power Steering pump hoses to pump. Torque hose clamps to 35 lbs. ft. (47 N.m)
3. Secure pump and bracket to engine.
4. Install drive belt and adjust to proper tension.
5. Fill and air bleed Power Steering system. See "Index" for proper instructions.